WYLER AG
Im Hölderli
CH-8405 WINTERTHUR
Switzerland

Tel. 0041 (0) 52 233 66 66
Fax. 0041 (0) 52 233 20 53

Homepage: http://www.wylerag.com
E-Mail: wyler@wylerag.com

USER'S MANUAL

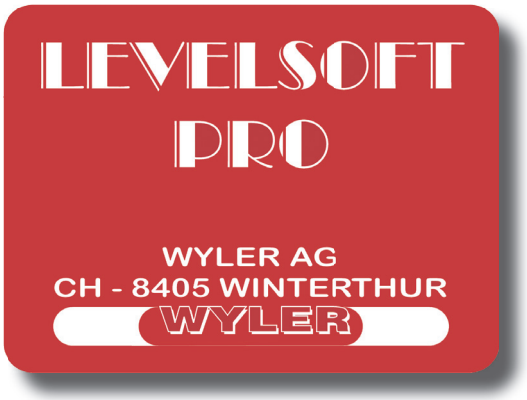
WYLER MEASURING AND COMPUTING SYSTEM

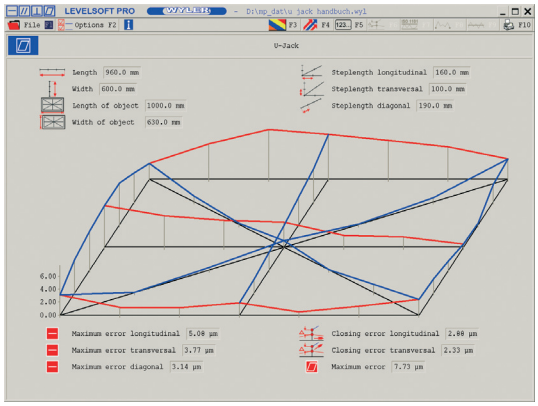
WITH

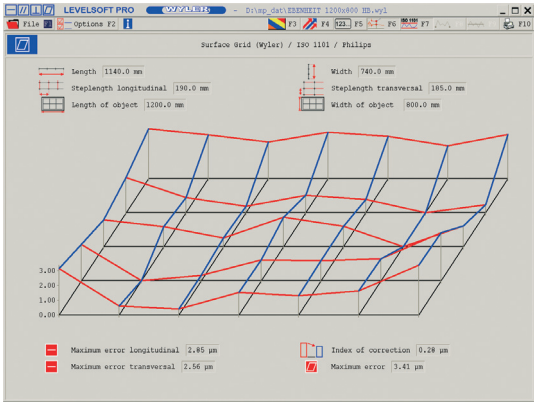
WYLER SOFTWARE FOR FLATNESS AND GEOMETRY MEASUREMENTS

LEVELSOFT PRO

WyBus-technology







ilac-MRA

SWISS CALIBRATION

Swiss Quality

Content

Theme			Page
1.	**INTRODUCTION**		**8**
	1.1.	Most imporatnt changes compared with the previous software	8
	1.2.	Software license agreement	9
2	**Installing the software LEVELSOFT PRO**		10
	2.1	Basic information concerning the setup	10
	2.2	The use of LEVELSOFT PRO, MT-SOFT or LabEXCEL WyBus for testing purposes	10
	2.3	Using LEVELSOFT PRO, MT-SOFT or LabEXCEL WyBus with a timely unlimited LICENCE	10
3	**GENERAL INFORMATION ABOUT MEASURING**		**12**
	3.1	Measuring strategy	12
	3.2	Verification of the system	12
	3.3	Choice of measuring base	14
	3.4	Influence due to temperature differences	15
	3.5	Differential measurement	16
	3.6	Measuring errors	16
	3.7	Measurement / Layout of measuring pattern	17
	3.8	Methods of alignment a) Alignment according to the method Endpoints b) Alignment according to the method ISO 1101 c) Alignment according to the method linear Regression	18
	3.9	Remarks concerning the “Limit of Variation”	19
	3.10	Remarks concerning the “Surveillance of drift”	21
	3.11	Pause	24
4	**PROGRAMME DIALOGUE**		25
	4.1	Starting the Software LEVELSOFT PRO	25
	4.2	Operating with mouse and the console	26
	4.3	Example of self explanetary icons	26
	4.4	Explanations to the measurement / measuring pattern	27
	4.5	Menus and Icons (Symbols)	27
	4.6	Dropdown-Menus „File“ and „Options“	28
	4.7	Meaning of the individual icons	29
		4.7.1 Open existing file	30
		4.7.2 Save measurements	31
		4.7.3 Print measurements	32
		4.7.4 Export of Measuring Data in Unicode-Format	35
		4.7.5 Start measurement	36
		4.7.6 Measuring pattern new/change	37
		4.7.7 Open measuring pattern	38
		4.7.8 Save measuring pattern	39
		4.7.9 End program	39
		4.7.10 Back	39
		4.7.11 Change language	40
		4.7.12 Change measuring unit	40
		4.7.13 Change scale	41
		4.7.14 Set up printing standard	41
		4.7.15 Change standard text	42
		4.7.16 Adjust main window	42
		4.7.17 Changing standards	43
		4.7.18 Back	43
		4.7.19 Definition of a measuring pattern	44
		4.7.19.1 Measurement information	45

	4.7.19.2	OBJECT	46
	4.7.19.3	WAY OF MEASURING	49
	4.7.19.4	SENSITIVITY	70
	4.7.19.5	LIMIT OF VARIATION	70
	4.7.19.6	SURVEILLANCE OF DRIFT	70
	4.7.19.7	LIMIT OF DRIFT ADMISSIBLE	70
5	**MEASUREMENTS ON MEASURING OBJECTS**		**71**
5.1	GENERAL REMARKS / DIALOGUE IN STATUS LINE		71
	5.1.1	ADDRESSING AN INSTRUMENT	71
	5.1.2	FIRMWARE-UPDATE	71
	5.1.3	MEASURING INSTRUMENTS CONNECTED TO THE INTERFACE BY CABLES OR WIRELESS DATA TRANSMISSION	74
	5.1.4	POSSIBLE ERROR MESSAGES	77
	5.1.5	SWAPPING THE INSTRUMENTS DURING THE MEASURING PROCEDURE	78
5.2	MEASUREMENT OF LINES, DESCRIBED IN DETAIL		80
5.3	MEASUREMENT OF LINES WITH TWIST		91
5.4	MEASUREMENT OF PARALLELS		94
5.5	MEASUREMENT OF PARALLELS WITH TWIST		98
5.6	MEASUREMENT OF FLATNESS		102
	5.6.1	SURFACE „SURFACE GRID (WYLER)“ DIN 876 / PART 1 (GRID)	102
	5.6.2	SURFACE “RECTANGLE” / MEASUREMENT OF GUIDE WAYS	117
	5.6.3	MEASUREMENT OF SURFACE , METHODE„UNION - JACK“	121
	5.6.3.1	MEASUREMENT OF SURFACE METHOD „US UNION - JACK“ CONVENTIONAL METHOD MEANING - ENTERING DATA MANUALLY	121
	5.6.3.2	MEASUREMENT OF SURFACE METHOD „US UNION - JACK“ USING THE LAYOUT PROPOSAL,	129
		OPTION A WYLER BASE 150 MM	132
		OPTION B WYLER FLEX BASE 250 MM	142
	5.6.4	FLATNESS MEASUREMENT OF PARTIAL AREAS	156
5.7	MEASUREMENT OF RIGHT ANGLE OBJECTS (SQUARENESS)		162
5.8	MEASUREMENT OF THE SQUARENESS OF A GRANITE MASTER SQUARE		173
5.9	LINE ABSOLUTE / MEASUREMENT OF AN OBJECT WITH VALUES ABSOLUTE		182
6	**ANNEX**		**191**
6.1	DETAILED INFORMATION CONCERNING THE THEME “ALIGNMENT OF COMPLEX MEASURING OBJECTS”		191
6.2	DETAILED INFORMARTION CONCERNING THE THEME „STANDARDS“ / QUALITY OF THE MEASURED OBJECT		193
6.3	INFORMATION ABOUT „SYMMETRIC, RESPECTIVELY ASYMMETRIC LAYOUT” OF THE MEASURING AREA		194

Änderungen / Modifications:

Datum / Date	Geändert durch Modified by	Beschreibung der Änderung Description of modifications
May 2/2002	HEH	Changes concerning letter head printing (logo), measuring layout, international standards
July 15/2002	HEH/MO	Modifications concerning U-Jack Layout Proposal
Oct 14 2002	HEH/MO	Various modifications regarding SW version 1.4.07-L4.10
December 2003	HEH/MO	New: LINE ABSOLUTE / Measurement of an object with values absolute
March, 2007	HEH	New with CopyControl
January, 2009	HEH	New with WyBus-Technology
February 2011	HEH/MUE	Various modifications on reading in the instruments

Index

KEY WORD	Chapter	Page
A		
ADDRESSING OF THE INSTRUMENTS	5.1.1	71
ADJUST MAIN WINDOW	4.7.16	42
ALIGNMENT OF COMPLEX MEASURING OBJECTS	6.1	191
ALIGNMENT OF THE OBJECT	3.8	18
ANGLE 90 DEGREES (SQUARENESS)	5.7	162
ANGULAR ERROR OF INSTRUMENT, SQUARENESS MEASUREMENT	5.7	162
ANNEX	6	191
ASYMMETRIC LAYOUT GUIDANCE	6.3	194
B		
BASIC INFORMATION CONCERNING THE SETUP	2.1	10
BASICS FOR MEASUREMENT / GENERAL INFORMATION ABOUT MEASURING	3	12
BLUEMETER	4.7.19.3	49
BS 817	6.2	193
C		
CHANGE OF MEASURING UNITS	4.7.12	40
CHANGES COMPARED TO EARLIER VERSIONS	1.1	8
CHOICE OF MEASURING BASE	3.3	14
CLOSURE ERROR / CORRECTION OF CLOSURE ERROR	5.6.1	114
CLOSURE ERRORS	5.6	113
COMMUNICATION, INSTRUMENTS TO EXTERNAL DISPLAY UNIT BY CABLE	5.1.3	74
COMMUNICATION, INSTRUMENTS TO EXTERNAL DISPLAY UNIT BY RADIO MODULE	5.1.3	74
CONFIGURATION MEASURING SET-UP WITH/WITHOUT RADIO MODULE	5.1.3	74
CORRECT MEASURING BASE, CHOICE OF	3.3	14
D		
DEFINING A MEASURING PATTERN	4.7.19	44
DEFINITION OF A MEASURING PATTERN	4.7.19	44
DIFFERENTIAL MEASUREMENT / REFERENCE MEASUREMENT	3.5	16
DIN 876	6.2	193
DRIFT ADMISSIBLE	4.7.19.7	70
DROPDOWN-MENUS „FILE“ AND „OPTIONS“	4.6	28
E		
END PROGRAM	4.7.9	39
ENDPOINT METHOD	3.8	18
ENDPOINTS	6.1	191
ERROR MESSAGES	5.1.4	77
EXPORT OF MEASURING DATA IN UNICODE-FORMAT	4.7.4	35
F		
FIRMWARE-UPDATE	5.1.1	71
FLATNESS / “WYLER” (GRID) DIN 876 PART 1	5.6.1	102
FLATNESS / AUTOMATIC DEFINITION OF THE REQUIRED PARAMETERS LIKE THE STEP LENGTH, BORDER ZONE ETC. BY USING THE BUTTON <GRID PROPOSAL>	5.6 B	108
FLATNESS / DIRECT ENTERING OF THE PREVIOUSLY DEFINED/CALCULATED VALUES, SUCH AS STEP LENGTH, BORDER ZONE ETC.	5.6 A	106
FLATNESS / MEASUREMENT OF FLATNESS	5.6	102
FLATNESS „PARTIAL AREAS“	5.6.4	156
FLATNESS „RECTANGLE“	5.6.2	117
FLATNESS „US UNION - JACK“	5.6.3	121
FLATNESS STANDARDS	5.6.1	114
FLEXBASE WYLER	5.6.3.2	142
FLEXBASE WYLER / MEASURING PROCEDURE	5.6.3.2	142
G		
GGG-P-463C	6.2	193
GRAPHIC DISPLAY / CHANGE SCALE AND ADJUST PRINT OUT	4.7.13	41
GRID PROPOSAL	5.6 B	108
GRID SYMMETRIC, ASYMMETRIC	6.3	194
GUIDE WAYS / MEASUREMENT OF SURFACE RECTANGLE / MEASUREMENT OF GUIDE WAYS	5.6.2	117

HEADER DATA / SET UP MASK	4.7.3	32
HEADER SHEET ENTERING MASK	4.7.3	32
I / J		
ICONS / EXAMPLE OF SELF EXPLANATORY ICONS	4.3	26
ICONS / MEANING OF THE INDIVIDUAL ICONS	4.7	29
INDEX OF CORRECTION	5.6	113
INFLUENCE DUE TO TEMPERATURE DIFFERENCES	3.4	15
INSTALLATION / BASIC INSTALLATION	2	10
INSTALLING THE SOFTWARE LEVELSOFT PRO	2	10
INSTRUMENTS, SWAP DURING MEASUREMENT	5.1.5	78
INTERPRETATION OF THE RESULTS	3.2	13
INTRODUCTION	1	8
ISO 1101	3.8	18
ISO 1101	6.1	191
JIS	6.2	193
K		
KEYBOARD AND MOUSE	4.2	26
L		
LANGUAGE CHANGE	4.7.11	40
LAYOUT OF MEASURING PATTERN	3.7	17
LEVELADAPTER 2000	4.7.19.3	49
LEVELMETER 2000 SW-VERSION / CHECK	5.1.2	72
LEVELMETER 2000	4.7.19.3	49
LEVELMETER 2000 / SW-UPDATE	5.1.2	72
LEVELMETER LIGHT	4.7.19.3	49
LEVELSOFT PRO / PROGRAMME DIALOGUE	4	25
LICENSE AGREEMENT	1.2	9
LIMIT OF DRIFT ADMISSIBLE	3.10	21
LIMIT OF VARIATION	3.9	19
LIMIT OF VARIATION	3.9	20
LIMIT OF VARIATION	4.7.19.5	70
LINE ABSOLUTE / MEASUREMENT OF AN OBJECT WITH VALUES ABSOLUTE	5.9	182
LINEAR REGRESSION	3.8	18
LINEAR REGRESSION	6.1	191
LINES / MEASUREMENT OF LINES / STRAIGHTNESS	5.2	80
LINES WITH TWIST / MEASUREMENT OF LINE WITH TWIST	5.3	91
LOGO	4.7.3	32
M		
MASTER SQUARE (GRANITE)	5.8	173
MEASUREMENT / LAYOUT OF MEASURING PATTERN	3.7	17
MEASUREMENT OF OBJECTS	5	71
MEASURING BASE	3.3	14
MEASURING DATA OPEN FILE	4.7.1	30
MEASURING ERROR	3.6	16
MEASURING INFORMATION	4.7.19.1	45
MEASURING PATTERN	4.1	25
MEASURING PATTERN / DEFINING A MEASURING PATTERN	4.7.19	44
MEASURING PATTERN / EXPLANATIONS TO THE MEASUREMENT / MEASURING PATTERN	4.4	27
MEASURING PATTERN / NEW , CHANGE	4.7.6	37
MEASURING PATTERN / OPEN	4.7.7	38
MEASURING PATTERN SAVE	4.7.8	39
MEASURING STRATEGY	3.1	12
MEASURING UNCERTAINTY	5.6	113
MEASURING UNIT	4.7.12	40
MENU „FILE“	4.6	28
MENU „OPTIONS“	4.6	28
MENUS AND ICONS (SYMBOLS)	4.5	27
METHODS OF ALIGNMENT	3.8	18
METHODS OF ALIGNMENT	3.8	18
MINI T/C WITH AND WITHOUT RADIO TRANSMISSION	5.9	182
MOST IMPORTANT CHANGES COMPARED WITH THE PREVIOUS SOFTWARE	1.1	8

MOUSE AND KEYBOARD	4.2	26
O		
OBJECT	4.7.19.2	46
OPEN EXISTING FILES / MEASUREMENTS	4.7.1	30
OPTIONS ARE AVAILABLE / ADDITIONAL OPTIONS	5.2	87
P		
PARALLELS / MEASUREMENT OF PARALLELS	5.4	94
PARALLELS WITH TWIST / MEASUREMENT OF PARALLELS WITH TWIST	5.5	98
PARTIAL AREAS / FLATNESS MEASUREMENT	5.6.4	156
PRINT MEASURING DATA	4.7.3	32
PRINTER SET UP	4.7.14	41
PRINTING MEASURING DATA	4.7.3	32
PROGRAMME DIALOGUE	4	25
R		
REFERENCE MEASUREMENT / DIFFERENTIAL MEASUREMENT	3.5	16
REGISTRATION	2.2	11
RIGHT ANGLE OBJECTS (SQUARENESS)	5.7	162
S		
SAVE MEASUREMENT / MEASURING DATE SAVE	4.7.2	31
SCALE / GRAPHIC DISPLAY	4.7.13	41
SENSITIVITY	4.7.19.4	57
SOFTWARE LICENCE AGREEMENT	1.2	9
SQUARENESS / MEASUREMENT OF 90 DEG. OBJECTS	5.7	162
STANDARD TEXT CHANGE / DATA IN HEADER SHEET	4.7.15	42
STANDARDS	4.7.17	43
STANDARDS / QUALITY OF THE MEASURED OBJECT	6.2	193
START MEASUREMENT	4.7.5	36
STARTING THE SOFTWARE LEVELSOFT PRO	4.1	25
SURVEILLANCE OF DRIFT	3.10	21
SURVEILLANCE OF DRIFT	3.10	21
SURVEILLANCE OF DRIFT	4.7.19.6	70
SWAP INSTRUMENTS	5.1.5	78
SYMBOLS	4.3	26
SYMMETRIC, RESPECTIVELY ASYMMETRIC LAYOUT	6.3	194
SYSTEM CHECK	3.2	12
T		
TEMPERATURE DIFFERENCE / INFLUENCE OF TEMPERATURE DIFFERENCE	3.4	15
TOP SYMBOL LINE	4.7	29
TYPE OF FILE	4.7.1	30
UNION – JACK / DRAWING THE LAYOUT	5.6.3.2	145
UNION - JACK“ CONVENTIONAL METHOD MEANING / ENTERING DATA MANUALLY	5.6.3.1	121
UNION - JACK“ USING THE LAYOUT PROPOSAL	5.6.3.2	129
UNION - JACK“ USING THE LAYOUT PROPOSAL / WYLER BASE OPTION “A”	5.6.3.2	129
UNION - JACK“ USING THE LAYOUT PROPOSAL / WYLER FLEXBASE OPTION “B”	5.6.3.2	142
V		
VARIATION / LIMIT OF VARIATION	3.9	20
VERIFICATION OF THE SYSTEM	3.2	12
W		
WAY OF MEASURING	4.7.19.3	49

1 INTRODUCTION

Thank you for choosing the WYLER-Measuring software LEVELSOFT PRO.

1.1. MOST IMPORATNT CHANGES COMPARED WITH THE PREVIOUS SOFTWARE

With the new version a significant amount of improvements are incorporated making life easy for the user. With this new LEVELSOFT PRO a never known functionality and individuality has been reached.

The most important improvements are:

- A large number of options may be changed even during the measurement
    - Language
    - Measuring units
    - Scale of display
- The file handling (open, save etc.) are now conform to most of the Windows applications
- Special standard forms are easily created and saved for later use
- For most of the actions and procedures easily understandable pictograms are installed to help with the usage
- Additional information is available with the graphic display, many of them long-time customer requirements
- On button click it is possible to switch between all the different alignment methods. The same procedure is possible for activating/deactivating the Philips correction (closure error)
- All commands are possible with mouse click or with keyboard use
- The document print out is easily adaptable to the individual requirements.
- Print out of own Logotype on protocol head
- Automatic definition of quality according to different international standards
- Automatic proposal of a measuring layout for flatness measurements on objects
- Save and open of individual standard texts for the printout of protocols

1.2. SOFTWARE LICENCE AGREEMENT

PRODUCT LICENCE AGREEMENT WYLER AG
CH-8405 WINTERTHUR / SWITZERLAND

The following is our standard licence agreement. The licence issued with each product will have the product name (e.g. LEVELSOFT or DYNAM) substituted for the words "the program" where they appear below.

1. WYLER AG licences you to use the program (including the installation program) provided that you comply with the following:
    a. You (or your duly authorised employees) will be the only person to use the program. Employees authorised by you are permitted to use the program for your purposes only.
    b. You only copy the program onto the hard disk of your computer. That where the software is installed on any multi-user or networked computer system, you will purchase a separate licence for each computer that will access to the program.
    c. That at any one time the program (or any part of it) does not exist in the memory (ROM or RAM, or any other type of memory) of more than one computer.
    d. That you do not alter, modify, reverse engineer, reverse assemble or reverse compile the program or the Install program.
    e. That you do not assign, sell or otherwise transfer the program to another person or allow another person to use it.
    f. That you use the program in accordance with the instructions provided

2. Subject to the existing laws, by the giving of the licence WYLER AG IS NOT:
    a. Giving you any title to or ownership in the program
    b. Accepting any responsibility for any damage caused by, or as a consequence of the operation of the program.

3. WYLER AG makes the program available in good faith and believes that it functions as described in the documentation. While we intend to continue developing the program, and would like to know of any problems that you experience with it, we are not undertaking in this licence to fix those problems. We reserve the right, in our absolute discretion, to fix any problems.

4. Should the distribution media supplied prove to be faulty then we will replace it provided it is returned within thirty days of us sending it to you.

5. This licence is and will be governed and interpreted according to the law of SWITZERLAND.

IT IS A BREACH OF THE COPYRIGHT ACT TO COPY THE PROGRAM WITHOUT OUR PERMISSION. THE ACT PROVIDES FOR A FINE TO BE IMPOSED ON ANY PERSON WHO COPIES THE SOFTWARE WITHOUT PERMISSION. WE WOULD ALSO BE ENTITLED TO SEEK DAMAGES IN THOSE CIRCUMSTANCES. IF PEOPLE MAKE USE OF THE PROGRAM WITHOUT PAYING THE LICENCE FEE THEN WE WILL BE DEPRIVED OF INCOME AND THE PROGRAM MAY NOT BE DEVELOPED FURTHER.
LEVELSOFT and DYNAM are trademarks of WYLER AG, CH-8405 WINTERTHUR / SWITZERLAND

2 INSTALLATION OF THE SOFTWARE LEVELSOFT PRO

2.1 BASIC INFORMATION REGARDING THE SETUP

For using the software **LEVELSOFT PRO**, **MT-SOFT** or **LabEXCEL WyBus** a licence is required. At first a free of charge test licence for a **period of 15 days** can be installed. The licence key required can be applied for through the Internet. For unlimited use a licence must be purchased through your local WYLER partner.

Recommended is a validation with a USB dongle. This is a hardware licence key integrated in a USB key. A main advantage of the activation with a dongle key is that you can install the software on different computers and, just connecting the dongle key, you can measure with each of these computers. Without the dongle connected you can still view or print completed measurements or you can prepare a next measurement or template.

2.2 The use of LEVELSOFT PRO, MT-SOFT or LabEXCEL WyBus for testing purposes

You have the opportunity to test the software **LEVELSOFT PRO, MT-SOFT or LabEXCEL WyBus** extensively as a **fully licensed version during a period of 15 days**. During or after expiry of this testing period you have the possibility to buy a full user license. The testing period expired, you can still use the software as a viewer version (no measurements possible, only viewing and printing of measuring results)

2.3 Using LEVELSOFT PRO, MT-SOFT or LabEXCEL WyBus with a timely unlimited LICENCE

In this case it is necessary to purchase an official software license through your local WYLER distribution partner **within 15 days**. WYLER SWITZERLAND will then validate your licence thus enabling you to use the software **LEVELSOFT PRO, MT-SOFT resp. LabEXCEL WyBus** without limitation.
In case you would like to use the software on various computers or Laptops we recommend the application of a USB dongle key (validation of the licence through a hardware key).

Further information on the installation and the licensing of the software can be found in the separate manual "Installation of the software LEVELSOFT PRO and MT-SOFT"

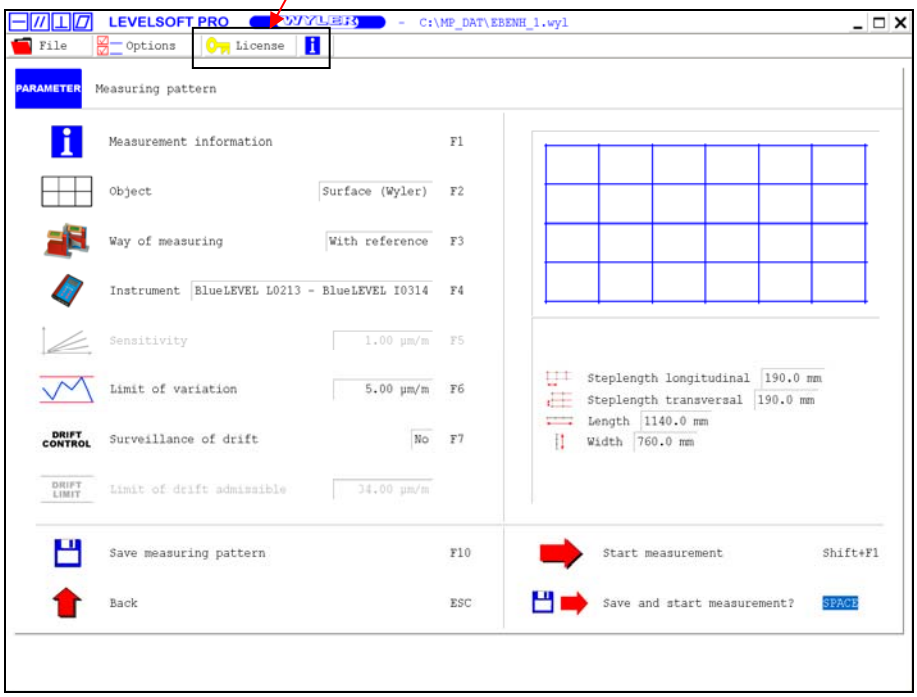
FOR FURTHER DETAILS REGARDING
- **I. INSTALLATION / BASIC INSTALLATION**
- **II. TRANSFER THE SOFTWARE LEVELSOFT PRO FROM ONE COMPUTER TO ANOTHER**
- **III. EXTENSIONS / UPGRADE**
- **IV. UPDATE / INSTALLATION OF A NEW VERSION**

SEE SEPARATE MANUAL "INSTALLATION OF LEVELSOFT PRO AND MT-SOFT“

In case of difficulties please contact WYLER AG

WYLER AG, CH 8405 WINTERTHUR
TEL **+41 52 233 66 66**
FAX **+41 52 233 20 53**
E-MAIL **wyler@wylerag.com**

Overview Licence key



IMPORTANT:
With this manual you will find a **REGISTRATION CARD** which we would ask you to complete and return by fax.

With returning the registration card you will be a registered user and have the following benefits:

- You will receive first source information on our new developments and activities
- You will receive the latest information on software updated
- You will help us to improve our products and services as well as the support by our distribution partners

Thank you in advance for your co-operation.

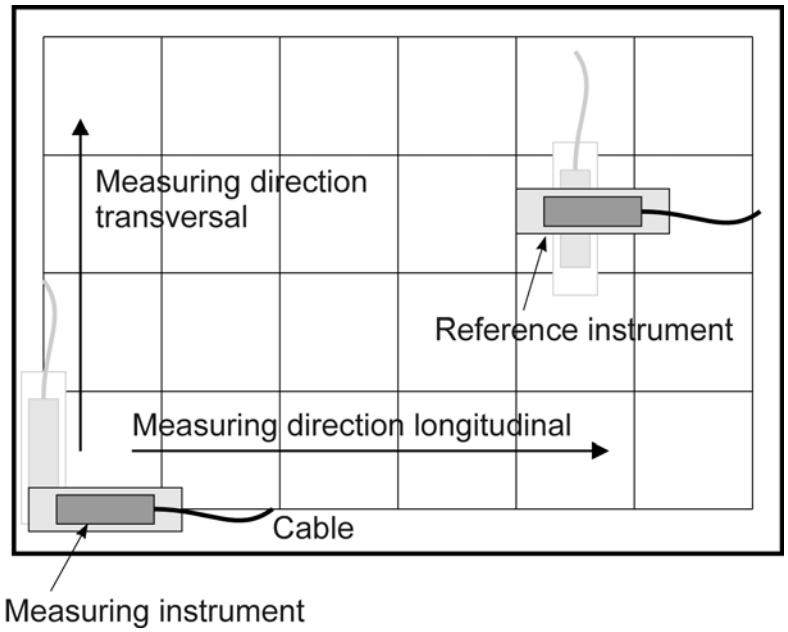
Note regarding Product Training
WYLER SWITZERLAND as well as the distribution partners in all countries hold regular **Product Trainings**. The aim of such trainings is the faultless handling of the measuring instruments and the operations of the software LEVELSOFT PRO.

Please contact the WYLER distribution partner where you have purchased the instruments to arrange a date for such training.

3 GENERAL INFORMATION ABOUT MEASURING

Before you start using the software LEVELSOFT PRO a few but important facts must be considered in order to come up with satisfactory results

3.1 MEASURING STRATEGY



- Touch the instruments only at the handle (Temperature!!!)
- Measuring from left to right and from close to far.
- Cable in measuring direction

3.2 VERIFICATION OF THE SYSTEM

- Install and power up the instruments and interface to PC according to the manual
- Start the software LEVELSOFT PRO / "Measuring pattern new/change"
- Enter Object "Line" /Step length longitudinal 100 mm / Number of measurements: 20
- Way of measuring, enter "1 Instrument" and <START MEASUREMENT> / [F11]
- Instrument is being initialised <CONFIRM> [F1] or [Shift] + [F1]
- Place a piece of newspaper (ca. 10 to 20 µm) under the right side of the measuring base.
- Without moving the electronic level read 10 values.
- Move newspaper to the left side.
- Read the remaining 10 values without moving the instrument.

The result should look similar to fig. 1

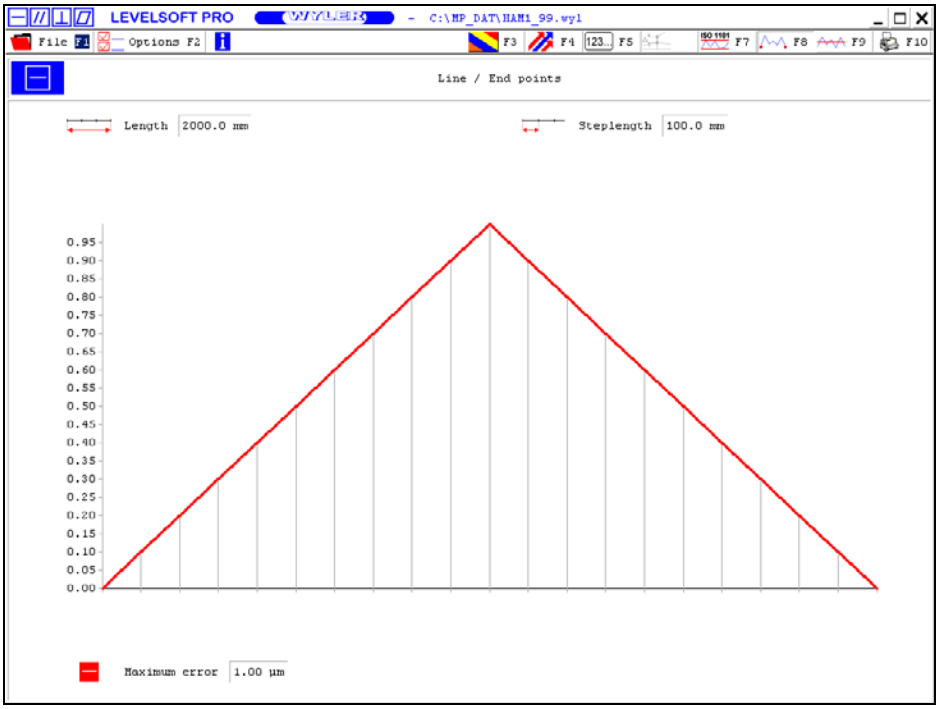
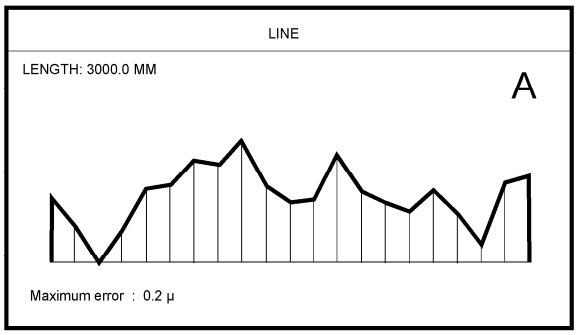
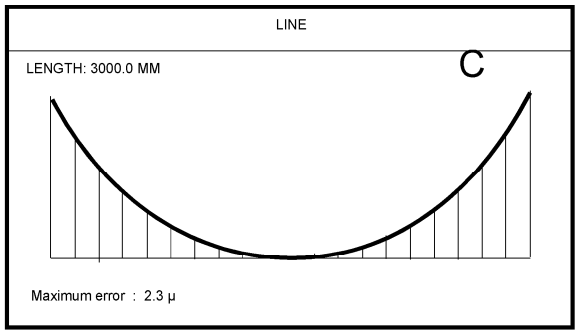


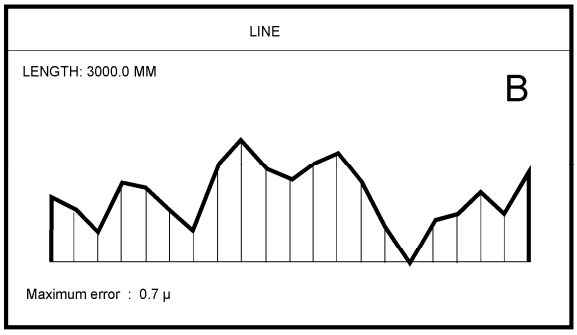
Fig. 1

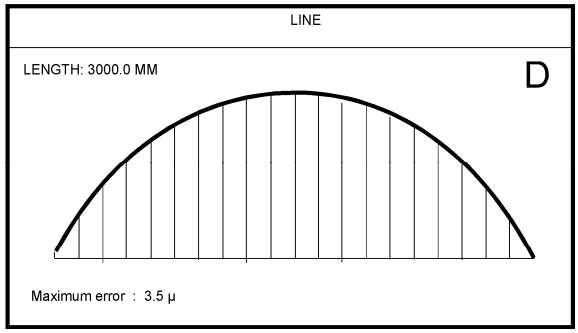
Repeat the same measurements without placing any paper below the instrument's base and without moving the instrument, which means the instrument remains flat at the same spot. The following could result:

Possible results









Interpretation of the results

Theoretically a straight line and a maximum error of "0" should be the result. This is however impossible due to unavoidable vibrations (movements of the object to be measured) and therefore changes in the measuring values on the electronic level. To obtain assertive measuring results the following conditions must be fulfilled:

For extremely precise measurements the maximum error must be less than 0.2 µm and a line character as shown in "A" or "B" must be obtained.

For medium accuracy of measurements the maximum error must be less than 0.5 µm and a line character as shown in "A" or "B" must be obtained. Such results can show up due to vibrations, these are random errors.

Line characteristics as per "C" or "D" must be avoided, as these are indication of temperature drift.

Possible causes

- Difference in temperature between the measuring base and the object.
- The whole system may not be at operating temperature or there are temperature differences within the object to be measured
  (Warm-up time for the electronic unit for precise measurements is 15 min.
  The adjustment of equal temperature within a measuring objects is depending on size and material and may need up to several hours.

Attention:
If a measurement is continued when line characteristic "C" or "D" are shown a time depending measuring error will show up. When the measuring task is time consuming the error will be quite large.
When measurement takes place after receiving curves similar to "A" or "B", even, when the errors are quite large, the displayed error must be added to the measuring uncertainty. These errors do not change over the period of time during the measurement. The errors may be influenced by other reasons, such as vibrations.

3.3 CHOICE OF MEASURING BASE

As far as possible for flatness measurements no instrument with prismatic base should be used (except as reference instrument). This is especially important for surface measuring!
Because the contact surfaces of longitudinal, respectively transversal measurements do not or not sufficiently overlap, errors can occur.

Also, scraped bases tend to collect dirt because the scraping pockets run out shallowly allowing dust particles to enter easily between the two surfaces.

The **hardened steel measuring bases with knife-edged type, approx. 1 mm broad dust grooves** under 45 deg. angle to the measuring direction, have proven especially suitable for measuring on surface plates of Diabas.

The following table gives an insight into dimensions and application ranges:

Length of measuring base mm	Width of measuring base mm	Length of contact of base section mm	Optimal measuring step length mm	Recommended range of measuring step length mm
110	45	20	90	85 - 105
150	45	24	126	120 - 145
200	45	30	170	160 - 190

Good results are also obtained for measurements on scraped or ground guide way-surfaces with measuring bases made of granite (Diabas).

Advantages:
Even if the granite bases are damaged no scratches on the work piece surface will occur.
The new developed adjustable measuring bases WYLER is an excellent alternative for precise measurement (see 5.6.3.2. The flexible base of WYLER). The users will be excited by the easy handling and the multiple options available. This base is conceptually adopted from the standardised 3-point-supported measuring bases, which also makes the use of the U-Jack-method a lot easier.

Particularly in combination with the latest version of our software LEVELSOFT PRO this measuring base is a convincing enhancement. This software allows the automatic calculation and proposal of a suitable measuring layout in an easy way, taking in account the high variety of possible step lengths provided by the Flexbase.

Another possibility is the use of an instrument with "screw-on" measuring base (Instrument's base length 150 mm) for mounting of larger bases (200 to 500 mm) which are built accordingly sturdy. If the screw-on type is used with short measuring bases, problems will occur unless the construction is very rigid. Rigid bases tend, due to the resulting weight, to deform the object to be measured (elasticity). This again results in measuring errors. Measuring bases with length of 200, 250 and 500 mm can be supplied by WYLER in Diabas as screw-on type. These are especially suitable for large tooling machines (Straightness and flatness measurement on guide-ways and tables).

Examples of incorrectly designed bases:

Absolutely flat base
Error:
No clearly defined contact points.
Full surface contact;
Tendency to wobble on uneven work piece surface, >> resulting in large measuring error.

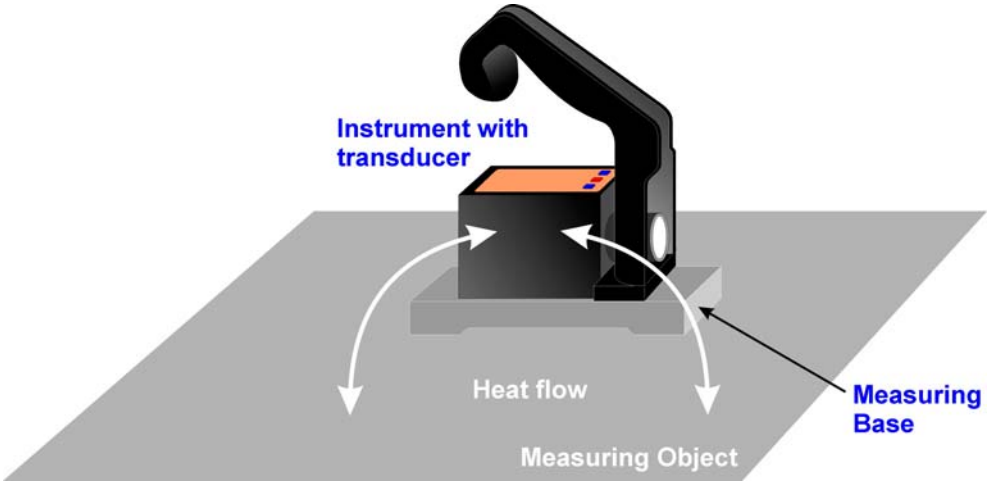
Measuring surfaces not covering the same surface area

Error:
measuring errors by line- and flatness-measurements

3.4 INFLUENCE DUE TO TEMPERATURE DIFFERENCES

Temperature difference within the work-piece or between the work-piece and the measuring base have a great influence on the accuracy of the measuring results. The following chapter will deal with some of these coherent problems.

Influence of temperature differences between the measuring base and the object to be measured



A temperature difference between the measuring base and the object to be measured will cause a heat flow. The amount of such a heat flow is depending on the area of contact, the difference in temperature, the materials of base and object as well as on the base length and the cross section of the measuring base.
In the base a temperature lamination will occur which will bend and warp the base because of material expansion. This will result in constantly changing the area of contact, which on the other side again will change the flow of heat. Consequently the measuring base is constantly in motion until temperature equivalence is achieved. These partially brisk motions can be observed by the continuously changing of the instrument's display value.
The temperature dependant volume changes of the base itself are also visible in the instrument's display value.

Important:

- Before conduction of a precision measurement the temperature of the instrument and the object must be checked!
- The time for temperature acclimatization of the instrument's base is depending on the temperature difference and the material used and will be between ½ and 2 hours.

Influence of temperature differences within the measuring object

The influence of the temperature difference within a measuring object can be demonstrated with the formula applied for calculating the deviation from flatness of a Diabas granite surface plate. The formula is valid for stable conditions only and deals with the difference of temperature between the bottom side of the plate and the topside of the plate.

Deviation from straightness (X)

$$X = \frac{D_T * a * L^2}{8 * B} \quad \text{in [m]}$$

DT = Temperature difference between top and bottom of the plate in deg. Kelvin
a = Coefficient of expansion of granite in (m) per deg Kelvin ($5.6*10^{-6} * °K^{-1}$)
L = Length of the plate (m)
B = Thickness of the plate (m)

Examples:

Length in	Thickness in	Deviation from straightness in DT = 0.2 deg. K	Deviation from straightness in DT = 1 deg. K	Allowable deviation according to DIN 876 Grade 00
(m)	(m)	(mm)	(mm)	(mm)
1.000	0.200	0.70	3.50	4.00
2.000	0.250	2.24	11.20	6.00
5.000	0.300	11.67	58.33	12.00
10.000	0.600	23.33	116.67	22.00

These examples show how much the influence of the temperature difference within a measuring object, is when a precision measurement has to be done.

3.5 DIFFERENTIAL MEASUREMENT

Measurements conducted with the differential method allow the compensation of slight changes of an object orientation during the measurement and the compensation of low frequency vibrations.
These compensations are only satisfactory if the measuring object is of rigid design and the supports are of the three-point type. Also the surface on which the reference instrument is placed must be a solid part of the object to be measured and of good flatness so that the reference instrument is not wobbling. If these conditions are not fulfilled the planned compensation cannot be achieved.

Attention
Long machine beds with several bearing points have the tendency of following the shape of the foundation, this will also give false compensation readings. By this the reference instrument placed on the machine bed will supply incorrect values. In these cases it is not recommended to apply differential measuring method.

3.6 MEASURING ERRORS

Possible causes of measuring errors, respectively closure errors of surface flatness measurements or poor repetition when measuring straight lines are:

- Temperature difference between measuring base and measuring object.
- Tilting of the object to be measured and/or vibrations during the measuring process.
- Careless measurement
- Dirt
- actuating the remote trigger before the instrument's read-out was stable
- insufficient overlapping of the measuring steps during the measurement
- careless positioning of the measuring instrument
- warped, worn or damaged measuring base
- uneven, short waved surface, bumps and burrs which cannot be covered accurately by the measuring base or result in wobbling of the measuring instrument.

3.7 MEASUREMENT / LAYOUT OF MEASURING PATTERN

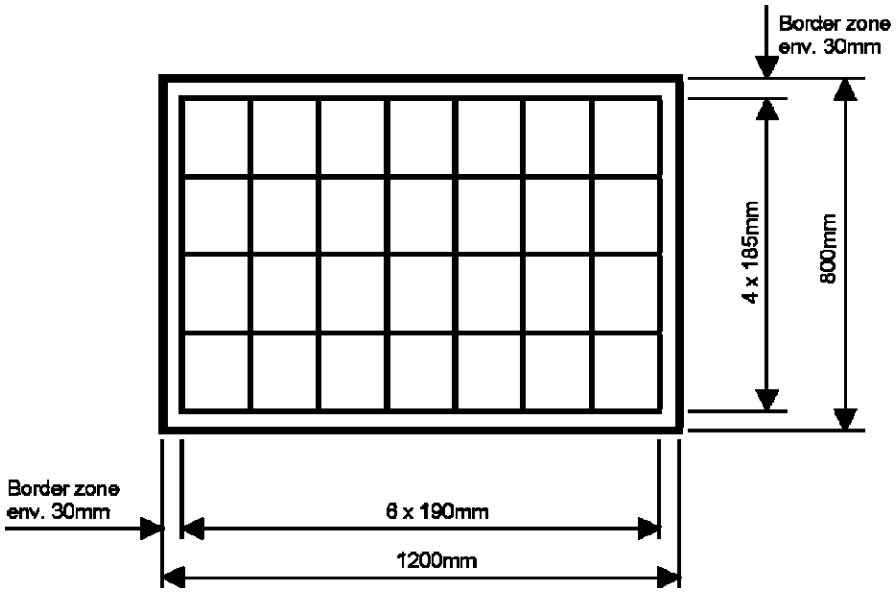
The object to be measured must be adjusted horizontally in both directions (longitudinal and transversal) as well as possible (within approx. 50 µm/m). If not done so, measuring errors may occur if the measuring instrument is not placed exactly in line with the measuring direction.
The object must now be divided in the measuring step length. The step length has to be such that an equal dimension of overlapping of the base length with each step is possible.
The best possible step length when using a 150 mm base is 126 mm.
As a guideline it should be noted that if the surface is of bad quality (rough, buckling) then the step length should be as close as possible to the optimal length (in this case 126 mm).

In addition it is important to make sure that the base as a whole comes to lay on the surface when placed in the measuring position.

The grid is to be marked on the surface plate with a pencil that does not apply a thick layer.

Example:

- Object to be measured: Surface plate 1200 x 800 mm
- Measuring instruments: BlueLEVEL, BlueLEVEL BASIC, Minilevel or Leveltronic, horizontal model, Base length 200 mm
  Optimal step length would be 170 mm



In our example the calculation was based on the border zone of 30 mm each side. The remaining distance is divided by the optimal step length, and then the figure set to either the next higher or lower round figure. The originally defined remaining distance must now be divided by the new fixed number of steps whereas the newly calculated figure is the step length to chose.

1200 mm - (2 x 30 mm) = 1140 mm
1140 mm : 170 mm = 6.7 Steps => 7 Steps; 1140 mm : 7 = 162.8 mm Step length
=> 6 Steps; 1140 mm : 6 = 190.0 mm Step length

Chosen step length 6 x 190 mm and on each side 30 mm border zone

The same method is to be applied for the other direction with a length of 800 mm

Chosen step length 4 x 185 mm and on each side 30mm border zone

On the side of the base the step length may be marked. Also the middle of the base may be marked at the front and at the end. By doing so it is assured that the measuring instrument is always placed correctly at the spot required.

See also specifications DIN 876 / Part 1

3.8 METHODS OF ALIGNMENT

In the WYLER LEVELSOFT 2000 the following methods of aligning the measuring objects are possible:

- Alignment according to the method “Endpoints”
- Alignment according to the method “ISO 1101”
- Alignment according to the method “linear Regression”

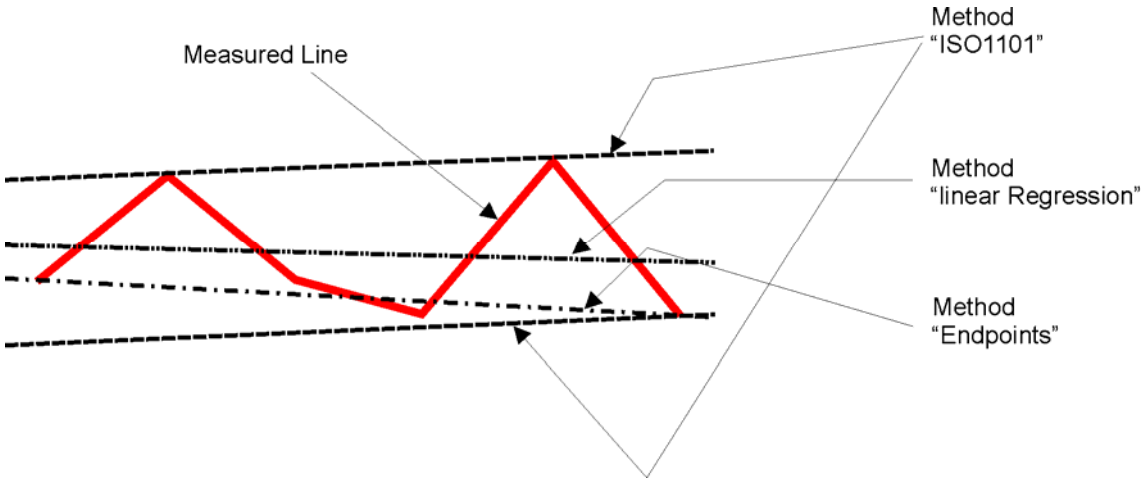
The different methods are described next and a number of graphics are used for better understanding. The same applies to the following measuring objects:

- Lines / Lines with Twist
- Parallels / Parallels with Twist
- Surfaces (WYLER Grid always ISO 1101)
- 90 deg. Angles (Squareness)

By aligning surfaces flat surfaces instead of straight lines are applied.

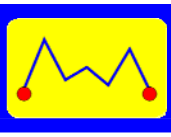
Procedure of the measurement:

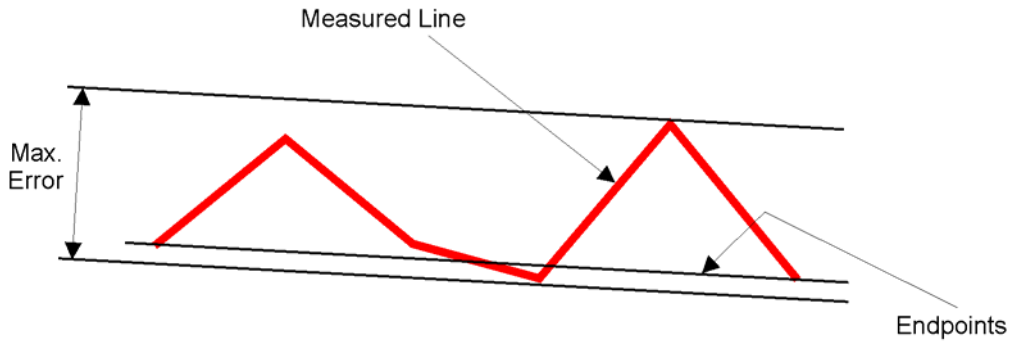
1. All the measuring parameters like e.g. step length, number of measurements, reading method, etc. are entered.
2. At the end of the measurement the result may be viewed using Menu point 2 “Display Profile”. The object is aligned as pre-set in Menu point 9 “Alignment method”
3. In menu points 7/8/9 "Alignment according to …" the required alignment method may be selected



Methods for aligning measuring objects, Overview:

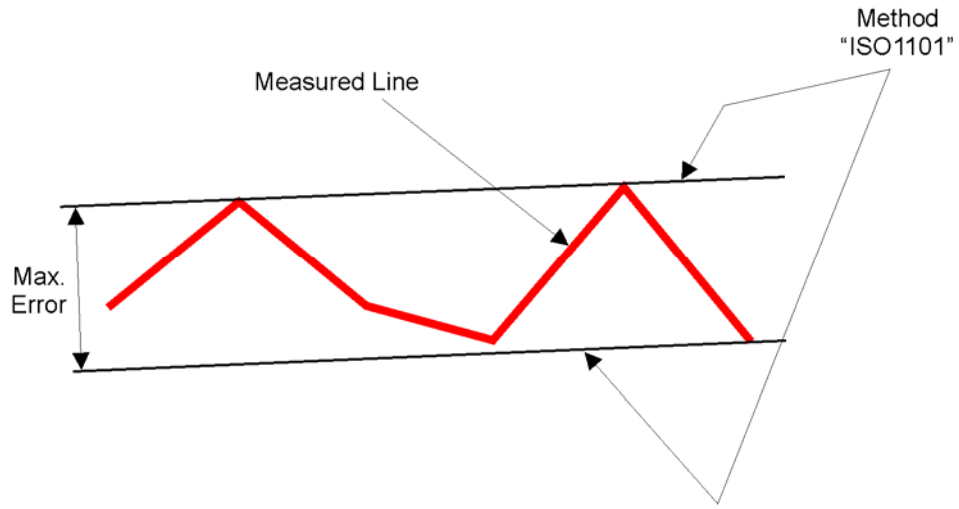
a) Alignment according to the method Endpoints





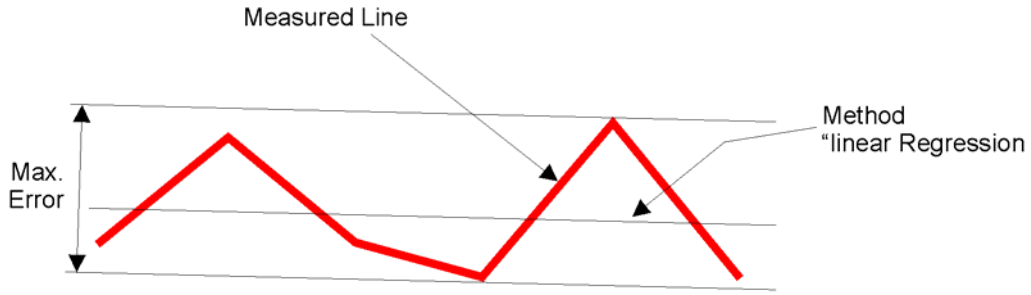
In this method the first and the last measured point are connected by a straight line. The whole figure is now turned horizontally. The connecting line is moved **parallel** to the highest and the lowest point of the object. The **vertical distance** between the two lines is the maximum error calculated according the method “Endpoints”.

b) Alignment according to the method ISO 1101



In the method ISO1101 two parallel lines are aligned in such away that the distance between them is the least possible.
The **vertical distance** between the two lines is the smallest possible error according the method “ISO 1101”

c) Alignment according to the method linear Regression

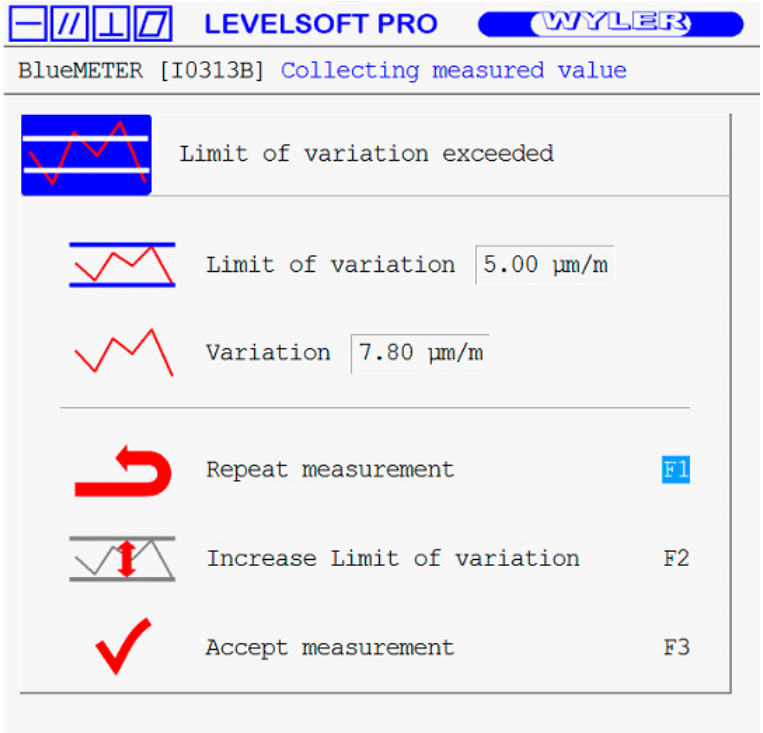


Using the method “linear regression” a straight line is calculated out of a number of measuring points according to the method least square.
The so calculated line is moved **parallel** to the highest and the lowest point of the object. The **vertical distance** between the two lines is the maximum error calculated according the method “Linear regression”.

3.9 REMARKS CONCERNING THE “LIMIT OF VARIATION”

Every measured value is computed out of series of individual values. The limit of variation is acting like a filter using only these values, which are within the set limit of variation.
During a measurement under true practical conditions a number of vibrations may be influencing the measurement in a way that the limit of variation needs to be adjusted. In most of the cases where such periodical vibrations are present this is a very efficient way to receive good measuring results because it will prevent relying on one individual measurement at a crucial time.
Under such measuring conditions it is recommended to start with a limit of variation of 5 µm/m. In case a series of measured values are rejected the system will repeat the measurement several times.

After several unsuccessful trials the following windows appear:



The following options are available:

1 => REPEAT MEASUREMENT	This will start a new sequence of trials to enter a series of sample values with a variation conforming to the set limit. Use this option whenever an occasional rejection occurs during measurement.
2 => ADJUST LIMIT OF VARIATION	Allow a higher variation to be accepted. NOTE: The system will offer a suitable value, which may be accepted by using the space bar. Any value, greater than the one presently set, may be entered by keyboard. This option should be taken after frequent rejection has occurred.
3 => ACCEPT MEASUREMENT	Accept the series of values read despite the fact that the variation exceeds the limit set. When measuring in difficult environment, the limit of variation should be set close to the variation of the measuring values. <u>Remarks:</u> When the “Limit of variation” will be changed during a measurement the setting is valid for the measurement in process. The new value will remain set until changed in the menu “Measuring parameters” "3 = > LIMIT of Variation“ or until the software will be started from new.

3.10 REMARKS CONCERNING THE "SURVEILLANCE OF DRIFT"

IMPORTANT:
The surveillance of drift should only be used by experienced users and measuring under extreme surrounding conditions (e.g. great temperature changes during the measurement).

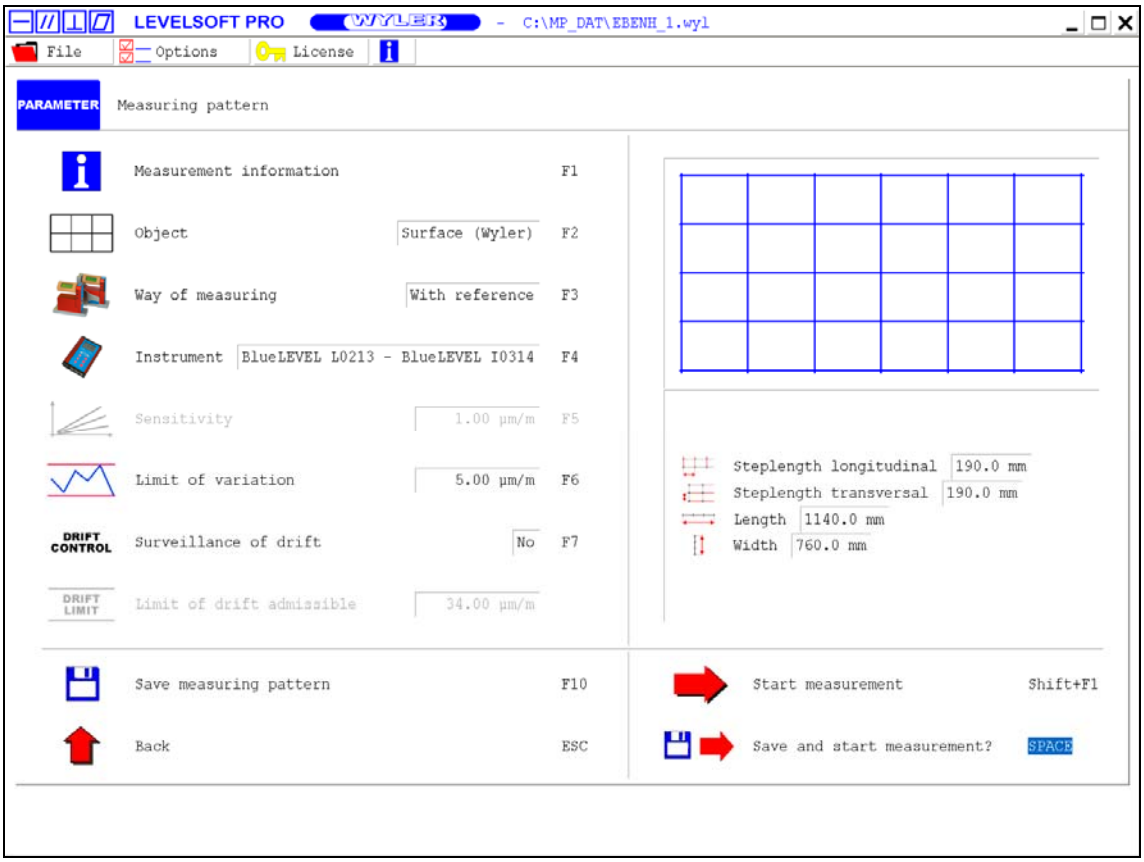
Various conditions like temperature changes or unstable supports during the measurement may have an influence on the instrument's absolute zero setting. With the activated "drift surveillance" a possibility is established to examine the drift condition.
When a measurement is taken with drift surveillance <ON>, the action to be taken will be called by the menu. For the correct procedure it is important to mark the measuring spots on which the drift condition of the measurement will be examined. The drift examination has always to be done with the instruments placed in the same direction as the **flatness measurement** is done. Therefore a place for every measuring direction must be available.

The drift examination is always relevant for the upcoming line measurement. It is therefore important to chose the correct moment for the examination, e.g. after the finishing of a line or at least after finishing the measurement of all the longitudinal and before changing to the transversal lines.

IMPORTANT:
The surveillance of drift is only available for the measuring objects "WYLER Grid" and "Rectangle".

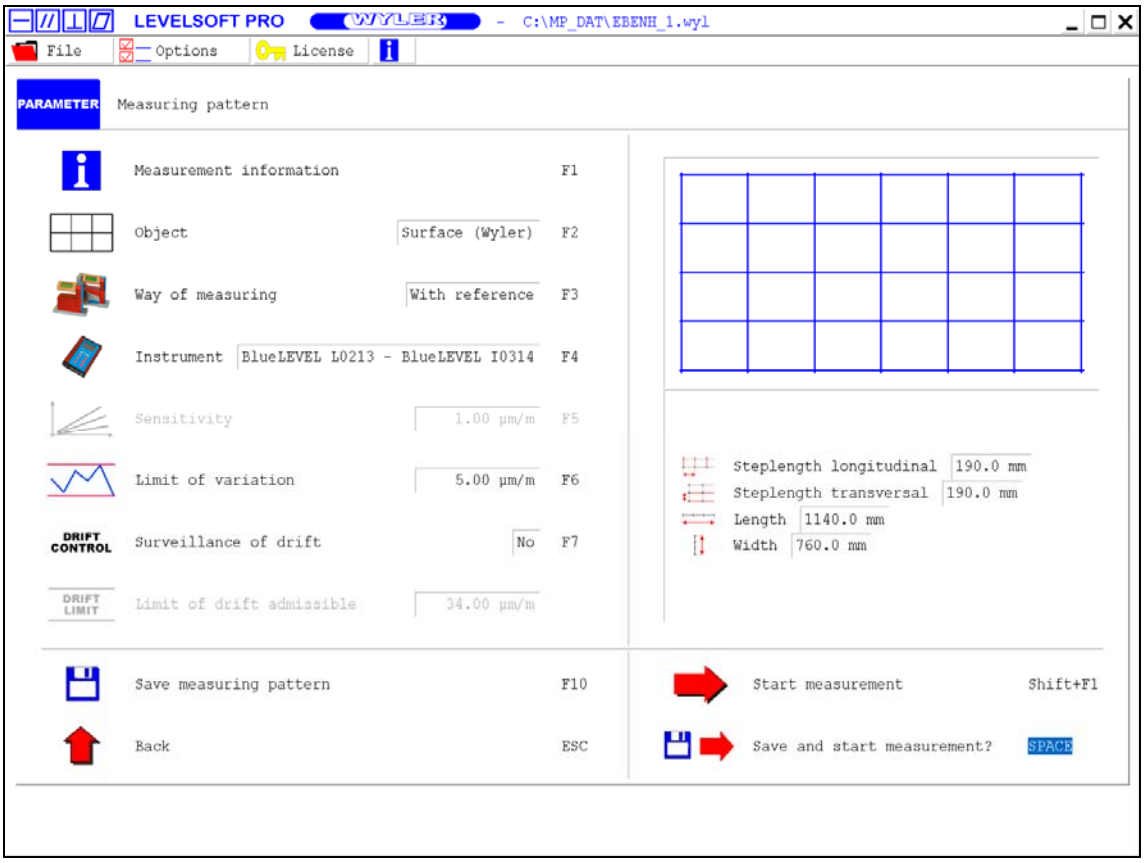
The instruments must be placed in the same direction as they are for the measurement.
If the differential measuring mode is applied, never change the position of the reference instrument while measuring a set of lines following the same direction.

During the definition of the measurement in point "Measuring pattern" (see picture below) the "Surveillance of drift" must be activated [F7]



By clicking to <Surveillance of drift> [F7] the surveillance of drift can be activated or deactivated.

If the surveillance of drift is confirmed with <YES> / [F1] the respective parameters for “Limit of drift admissible” may now be entered and the measurement can be started.

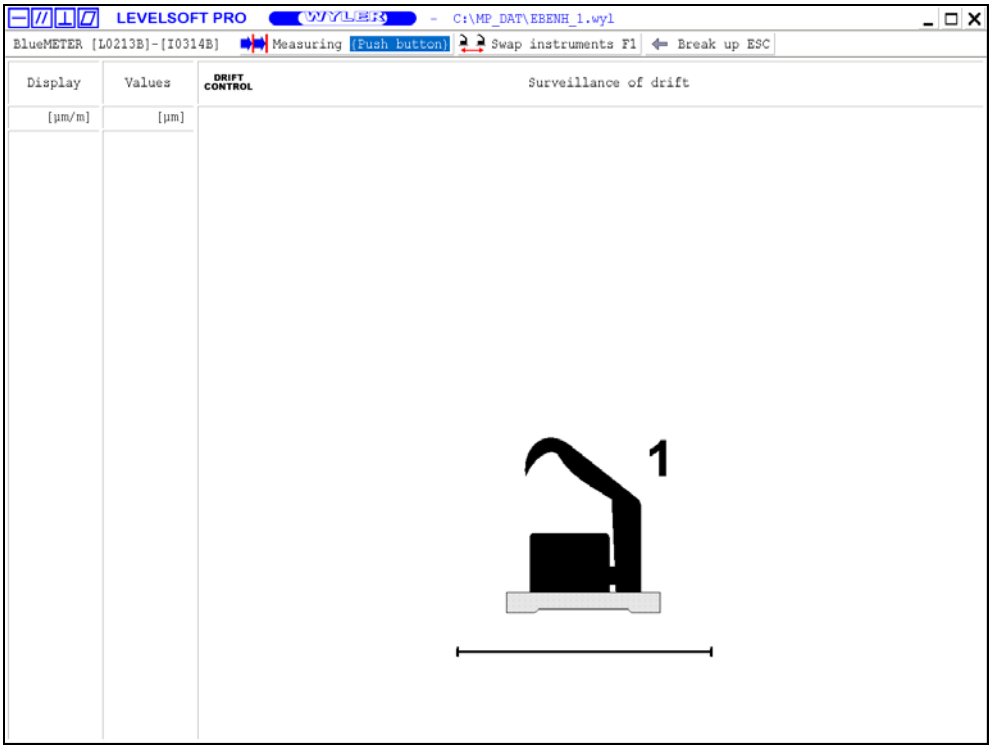


Now the measuring instrument must be set at the predefined place. When measuring a surface the instrument is to be placed in the measuring direction of the next measurement. If this next measurement is for a line in another direction the instrument must be placed accordingly! In case of a surface measurement the drift check must be performed after the last measurement in longitudinal direction, on the spot of the first measurement in crosswise direction.

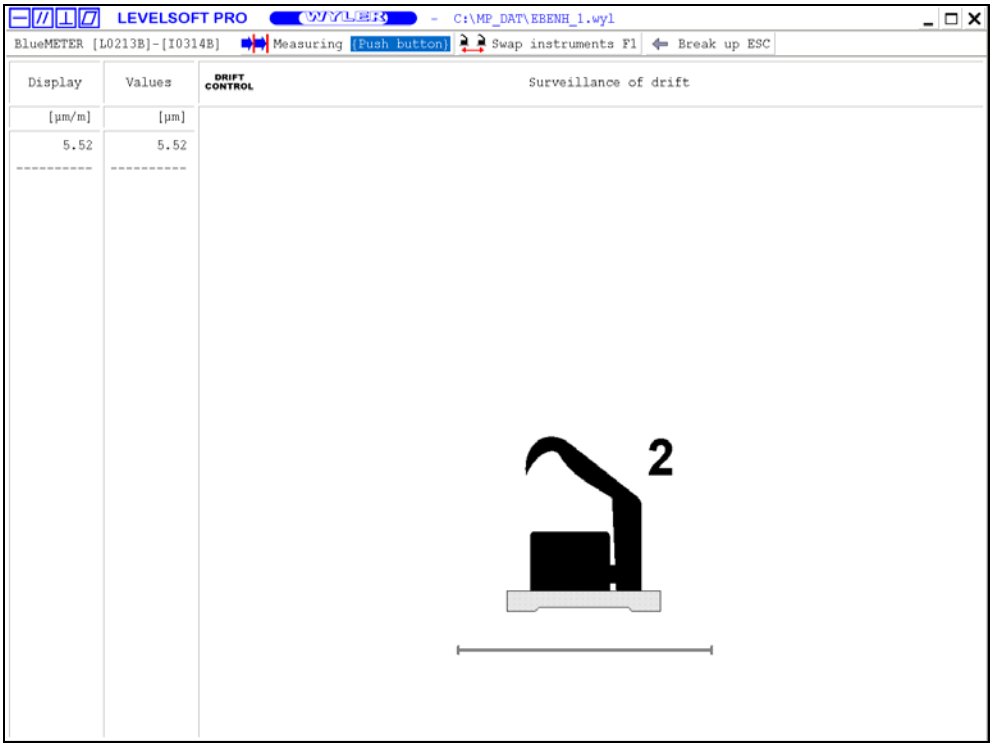
Before starting the measurement the instruments must be initialised. Follow the statements on the monitor

After initialising of the instruments the following display appears:

IMPORTANT:
The reference instrument must not be touched during the measurement!!!



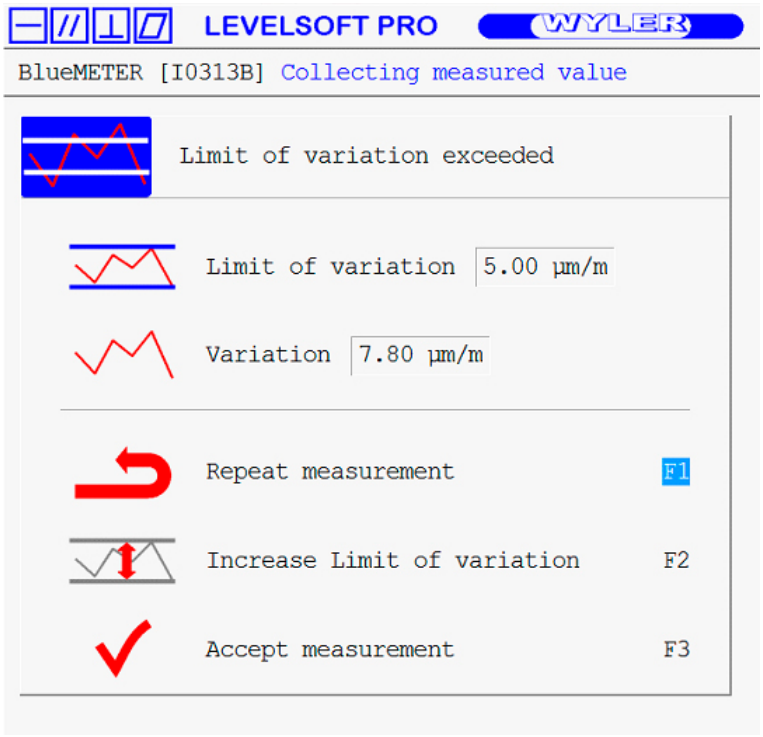
At every drift examination two measurements must be taken at the same spot. The corresponding result is displayed in the menu.



At the beginning of a measurement of every new line the drift control must be made according to the above described procedure.

The value of each drift measurement will be stored and compared with the previous one. If the value is within the pre-set tolerance, the measurement task will be continued and all the upcoming measuring results will be corrected by the measured drift value.

If the tolerance is not reached, the following remark will appear:

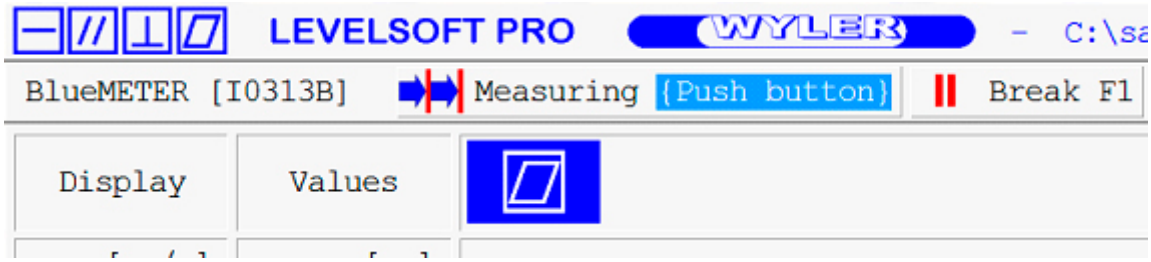


The following options are possible:

1. Retake measurement of drift
2. Change limitation of drift and continue the measurement
3. Accept measured drift and continue the measurement.

3.11 PAUSE

In order to avoid unintentional operation the control panels of the BlueMETER resp. the LEVELMETER 2000 are blocked during the measuring process. For very specific measuring tasks this blocking can be suspended by activating the key pause [F1]. During the pause no measurement can be taken. After pressing the key pause [F1] again the instruments will be re-initialised, the control panel will be blocked and the measurement can be continued.

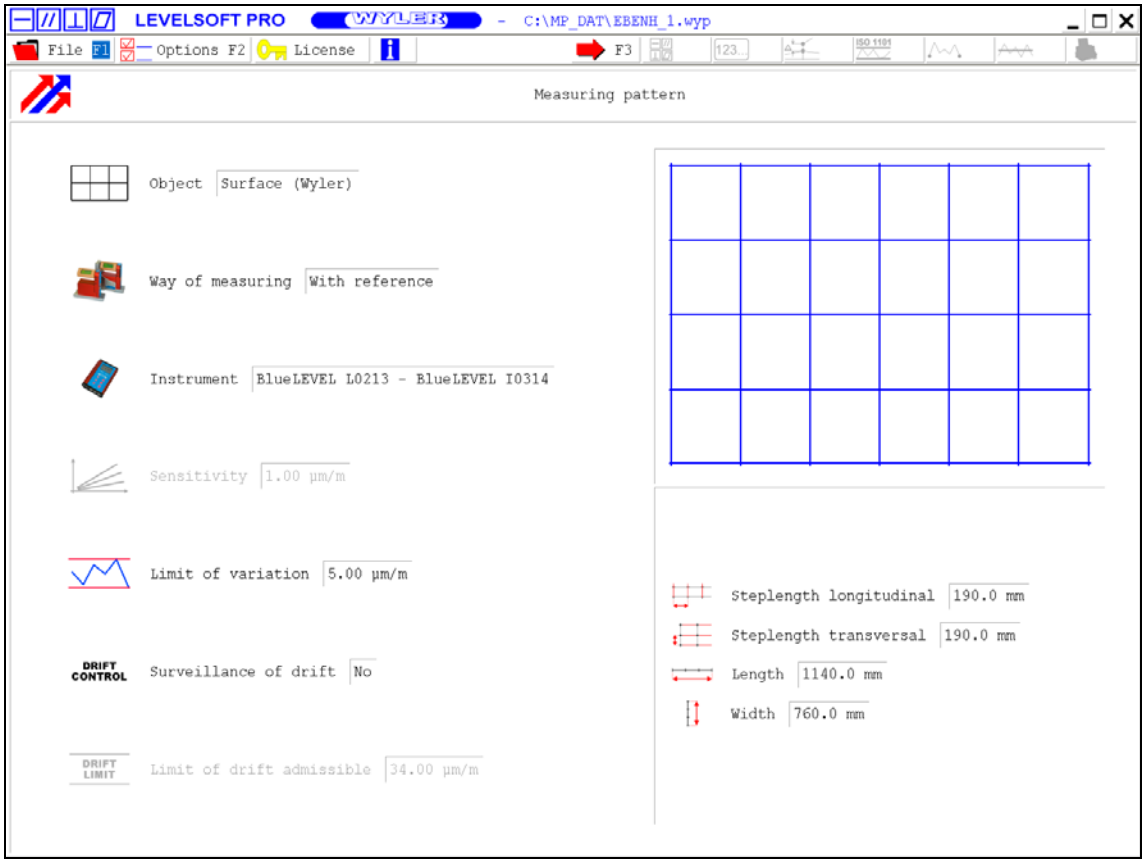


4 PROGRAMME DIALOGUE

4.1 STARTING THE SOFTWARE LEVELSOFT PRO

During the start process the following picture is seen for a short period of time:

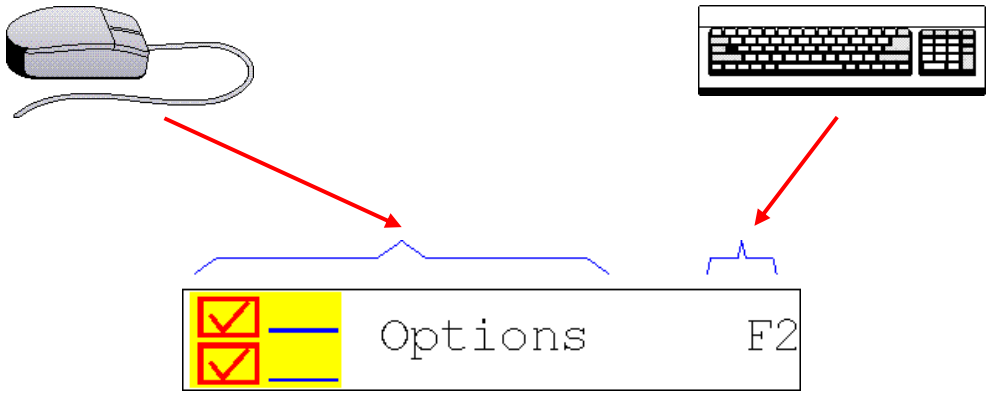
After that the **measuring pattern** last used is displayed:

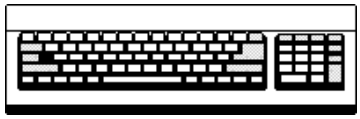
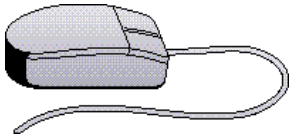


In our example it is a flatness measurement with two instruments (differential measurement), connected via a BlueMETER to the PC

4.2 OPERATING WITH MOUSE AND THE CONSOLE

The software is made for use with **mouse and console**

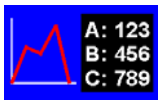


Using the keys [F1] to F12] of the keyboard	
Using the mouse for clicking the individual menu points and the entering fields	

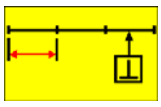
For better understanding the individual menu points and the information in the software LEVELSOFT PRO are complemented with **icons**

4.3 EXAMPLE OF SELF EXPLANETARY ICONS

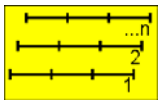
Measurement of squareness on a object, reference is on the top



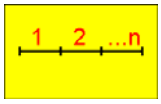
Print out of a graphic with numerical values in table form.



Step length of a line to be measured



Number of parallels



Number of steps of a line to be measured

Reversal measurement or change the direction of the measuring instrument

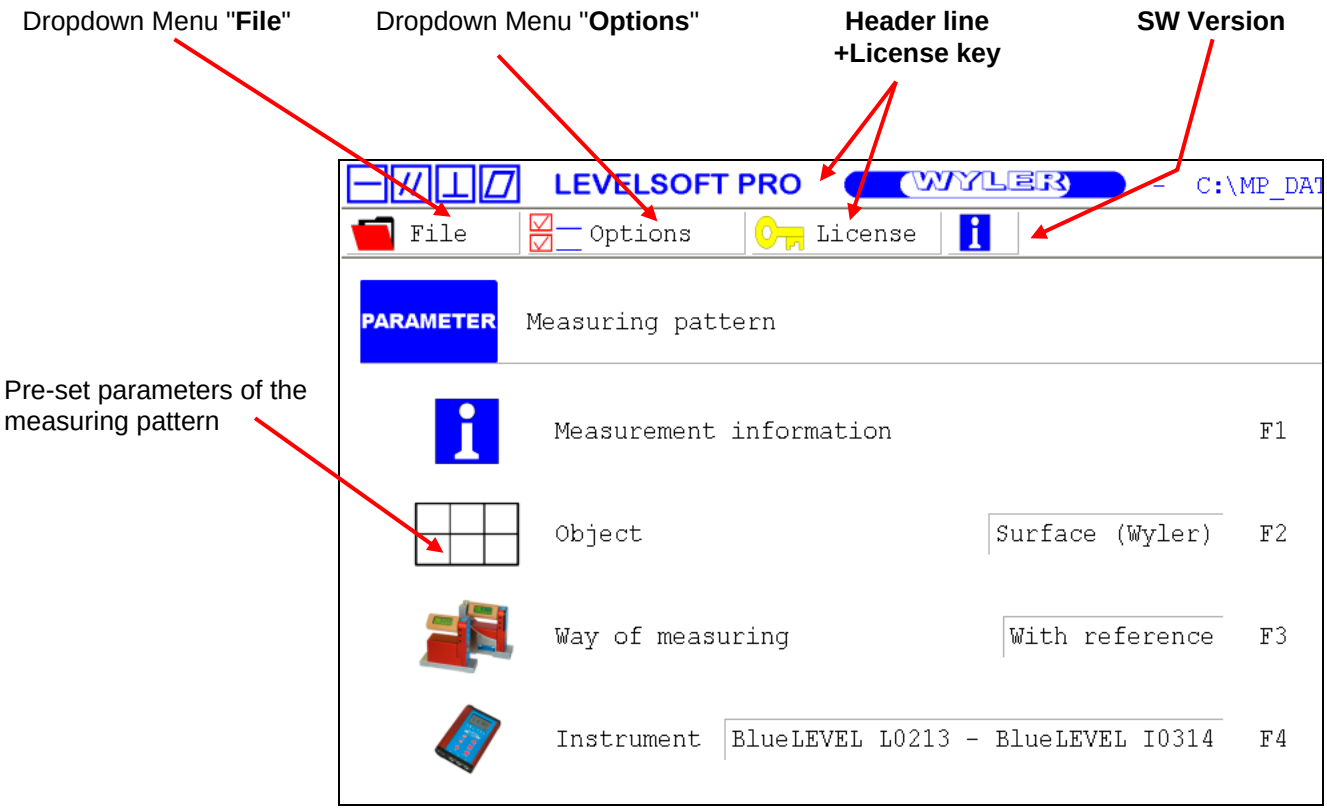
Files are memorised with different endings. We differentiate between

- a **measurement**, which is saved with the ending ".wyl"
  and
- a **measuring pattern**, which is saved with the ending ".wyp"

4.4 EXPLANATIONS TO THE MEASUREMENT / MEASURING PATTERN

- Every taken measurement, even when not specifically saved as a measuring pattern will at the next start of the software LEVELSOFT PRO be opened as a measuring pattern with the ending ".wyp"
- Every taken measurement can be saved as a measurement ending ".wyl" and/or as a measuring pattern ending ".wyp"
- Measuring patterns with the ending ".wyp" do not contain any measurement data, only the parameters are included such as e.g.:
  - Object
  - Way of measuring (one instrument, two instruments etc.)
  - Number of lines longitudinal/transversal
  - Limit of variation
  - Surveillance of drift including tolerance
- If the opened measuring pattern is correct for the planned measurement the measurement can be started immediately by clicking to the icon
  / or
  using the key [F3]

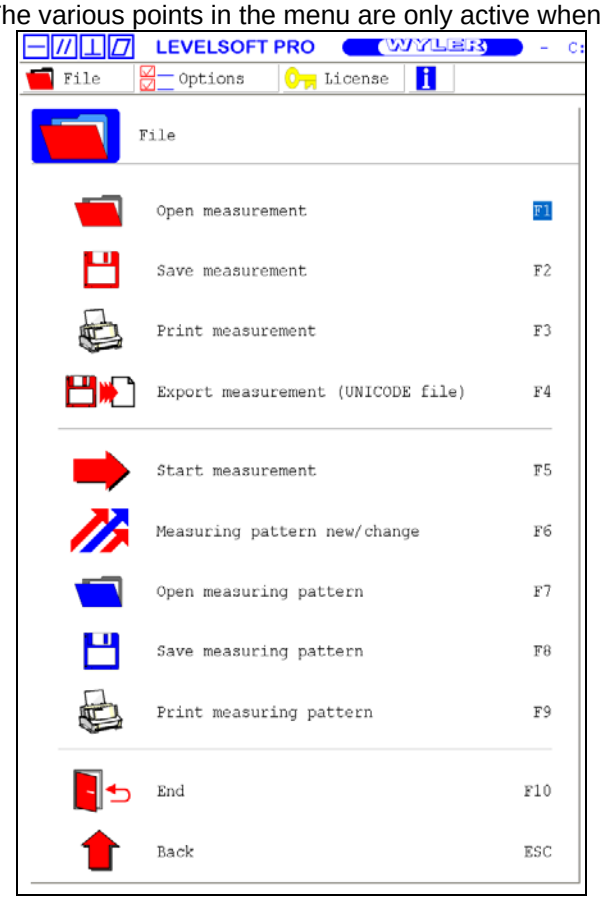
4.5 MENUS AND ICONS (SYMBOLS)



4.6 DROPDOWN-MENUS "FILE" AND "OPTIONS"

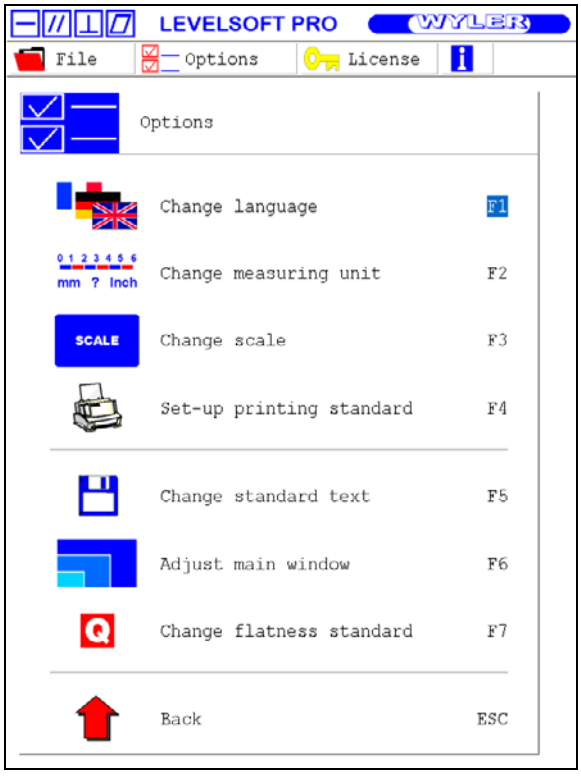
Menu "File"

The various points in the menu are only active when the actions are possible or make sense



- **Open existing file**:
  Open a file from the floppy or hard disk
- **Save measurement**
  Save the measured data to a file on the disk
- **Print measurement**
  Printing the results of a measurement. Printer set-up to be done under “Options”
- **Export Measuring Data**
  Export measuring data as a Unicode File
- **Start measurement**
  Starting a measurement from the active measuring pattern
- **Measuring pattern new/change**
  - Create a new measuring pattern
  - Change the actual measuring pattern
- **Open measuring pattern**
  Open an existing measuring pattern
- **Save measuring pattern**
  Save the actual measuring pattern. The ending will be ".wyp"
- **Exit**
  Close the software LEVELSOFT PRO
- **Back**
  Go back to the main menu

Menu "Options"

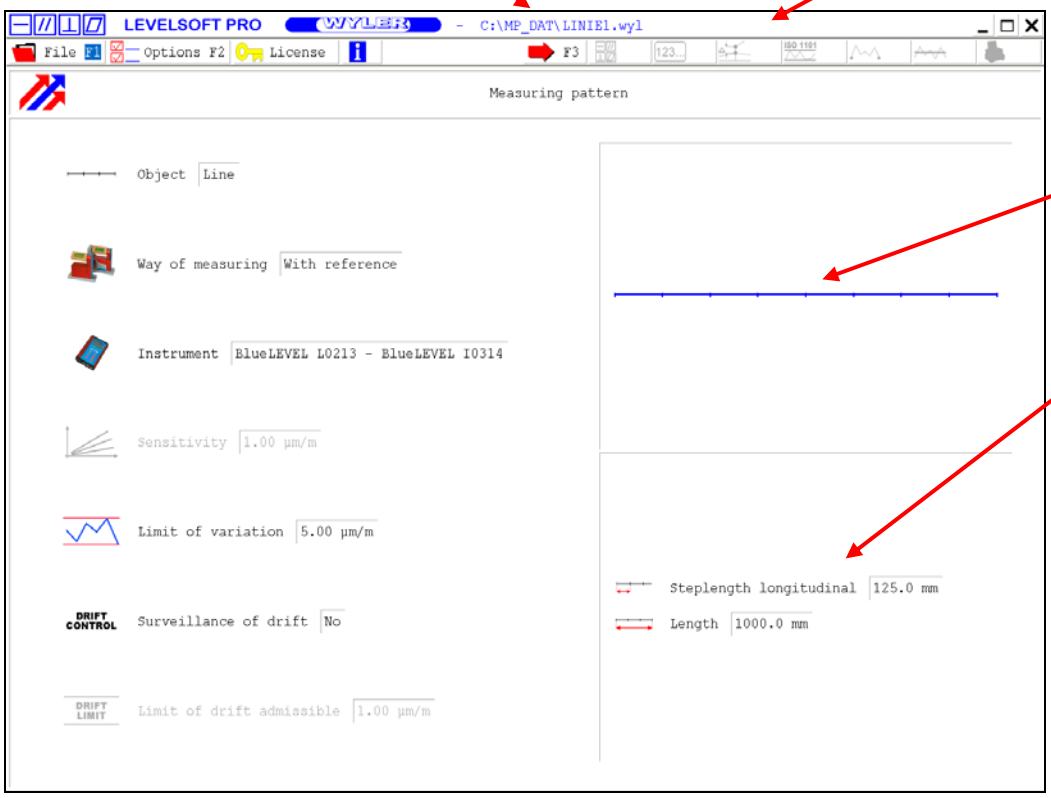


- **Change language**:
  Change the language for using the software and the print out
- **Change measuring unit**
  - Choice of "metric"
  - Choice of Imperial (Inch, sec. of arc)
  - Choice of Imperial (Inch, Inch/10Inch)
- **Change scale**
  Change the size of the displayed graphic on the monitor and on the print out
  - Automatic
  - User defined
- **Printer set-up**
  Set up of the printer parameters
  - Printing area
  - with/without numerical values
  - with/without profile in landscape
- **Change standard text**
  Set up of the standard text for the printing output
- **Adjust main window**
  Set up the windows size on the monitor
- **Flatness standard**
  Selection of the required flatness standard
- **Back**
  Back to the main menu

File-name (measuring pattern has ending "*.wyp")

Icons for

- "Start measurement“
- Alignment method
- Display of the individual numerical measuring values



Object, measuring pattern with information about geometry such as:

- Step length
- Total length
- etc.

4.7 MEANING OF THE INDIVIDUAL ICONS

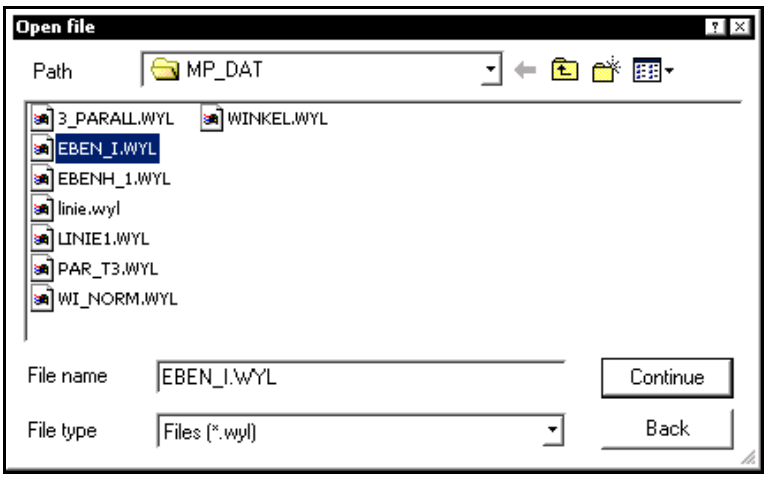
F3	**Start measurement** with the existing parameters	F6	Philips-correction of the **closure errors**
F4	**Switch from** actual measurement and measuring pattern with parameters	F7	Alignment according to **ISO 1101**
F4	**Switch** from the measuring pattern to the actual measurement with results	F8	Alignment according to **ENDPOINT METHODE**
F5	Display the **numerical measured values** of the various measuring points	F9	Alignment according to **LINEAREN REGRESSION (Least square)**

Details to the menu "File"

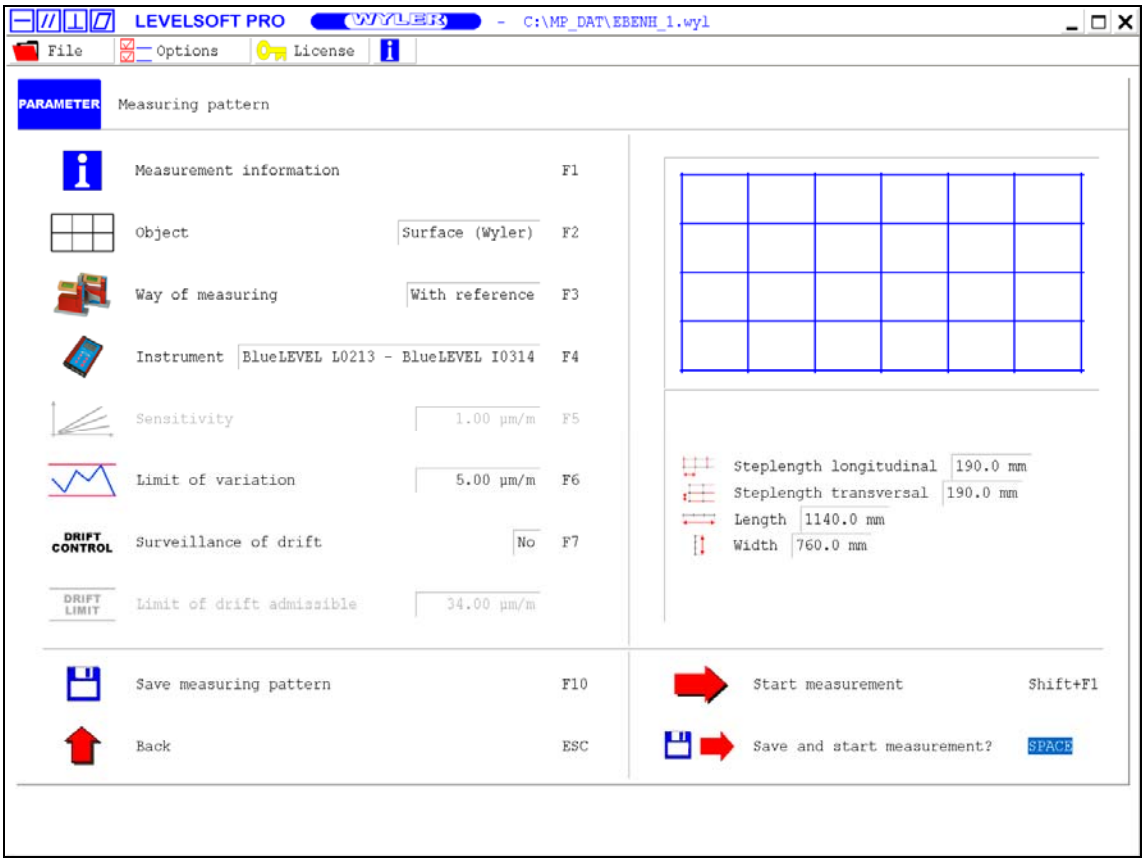
4.7.1 Open existing file

Open an existing file from the floppy or hard disk (Ending ".wyl")

When the menu point “Open existing file” is activated the following dialog box is opened:



The file type is "*.wyl", which means all the measurements saved as files are displayed. You can select the respective file and activate <Continue>. The selected measurement is displayed



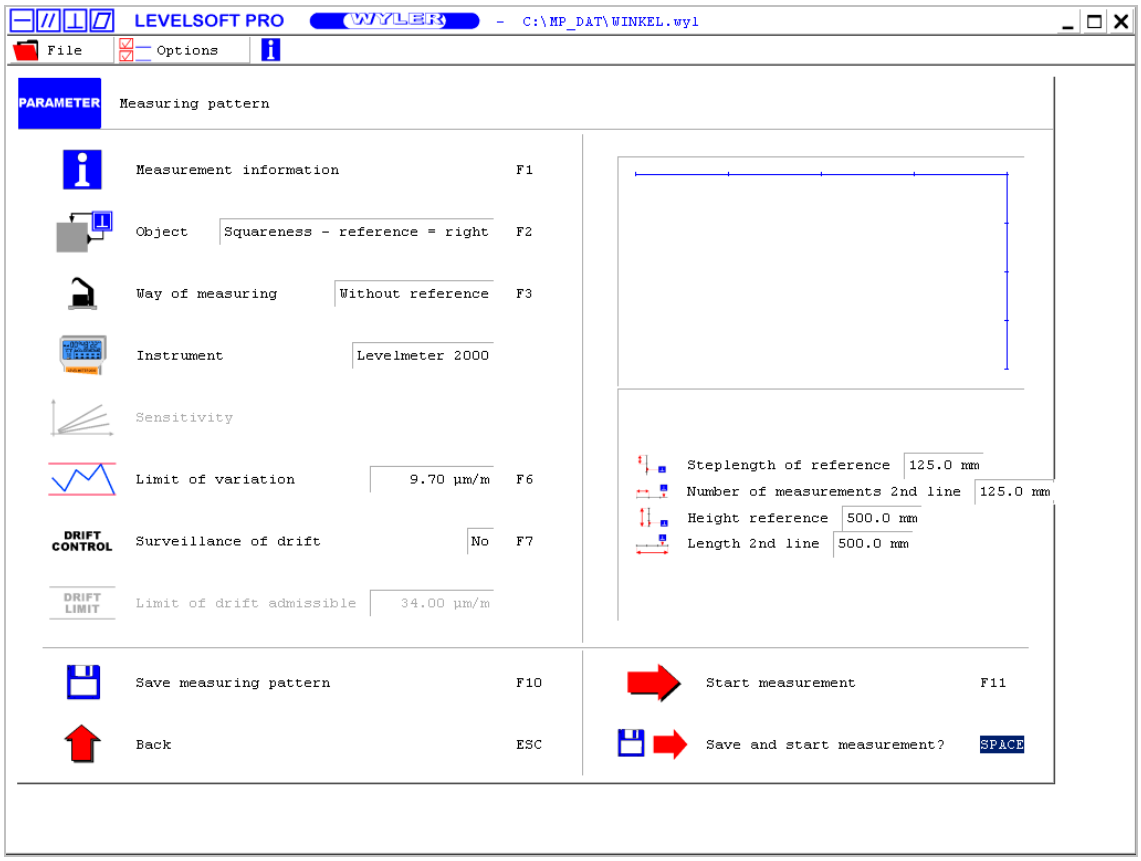
4.7.2 Save measurement

Save the measurement to the floppy or to the hard disk.

There are two options for saving available:

- Save as **measurement** (with ending ".wyl"). In this case the measuring object, the measuring parameters and the measured data as well as the text will be saved
  and
- Save as **measuring pattern** to be used for other measurements in future (with ending ".wyp") with the following possibilities:
  - A finished measurement with all the parameters inclusive the text for the print out head, **but without measuring data**, will be saved
  - Different measuring patterns may be defined. Using the menu point "Measuring pattern new/change" the individual parameters can be defined individually:
    - Object
    - Way of measuring (one instrument, two instruments etc.)
    - Instrument (if not defined by system)
    - Sensitivity (if not defined by system)
    - Limit of variation
    - Surveillance of drift
    - Limit of drift admissible (if drift control is activated)

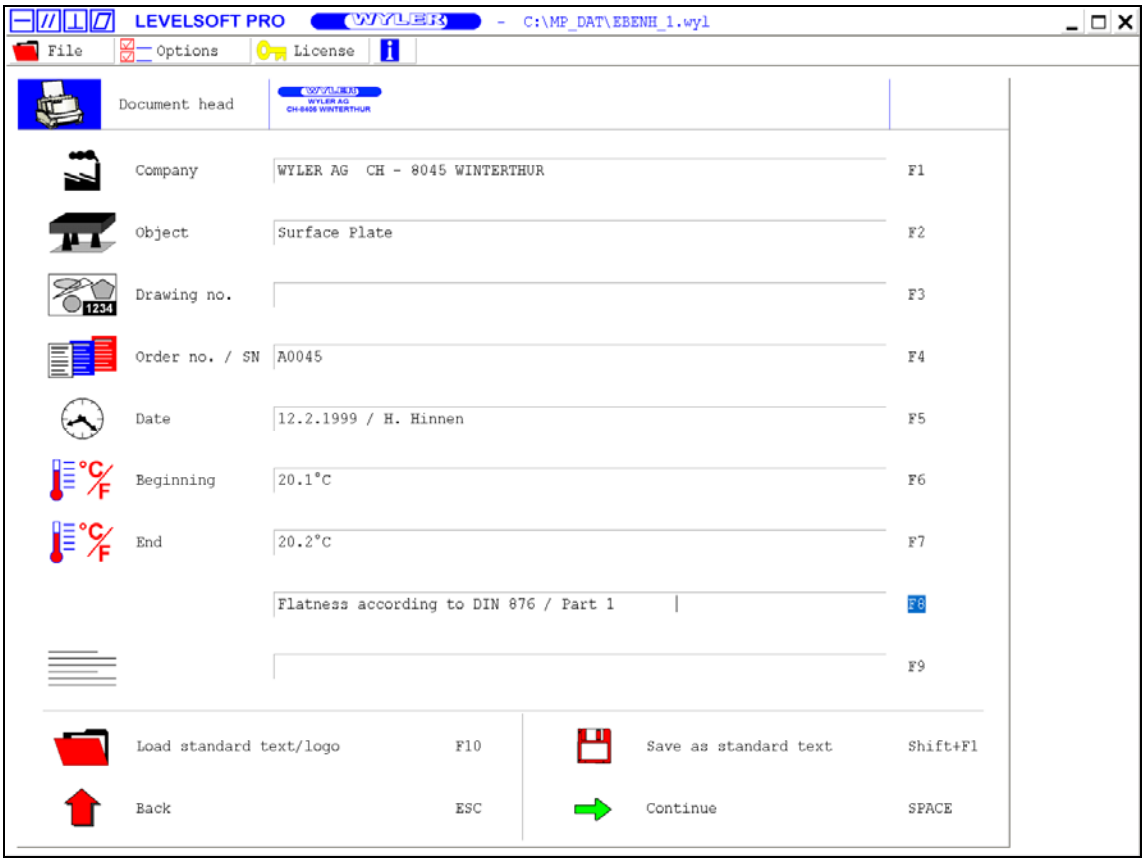
  Such a defined configuration may be saved as a measuring pattern (with ending ".wyp") and may be called at any time later. It is also possible to immediately start with a measurement now.



4.7.3 Print measurement

Printing the results of a measurement. Printer set-up to be done under “Options”.

After a measurement the results may be printed. Using the menu points “File / Print measurement” the following display is seen for entering the information later to be printed in header sheet.



When in a previously done measurement already a text and a logo was selected and included these items will be pre-set.
Additional possibilities:

a) create different standard text files as templates, save and open when required (ending "*.wyt")
b) create different logos, save and open, when required (ending "*.png")

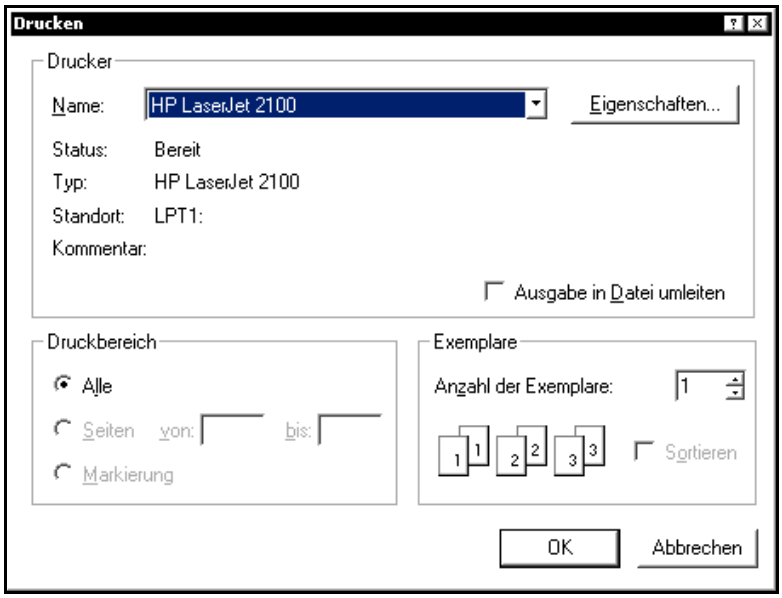
Using <Load standard text / logo> / [F10] the respective data may be selected and included in the opened text document. This text can now be changed if required and it could also be saved as a new text template <Save as standard text> / [F11]

The selected logo remains the default logo until changed from new.

Requirements for creating logos:

- Create your logo in a graphic software program (e.g. Corel Draw). Size must be 2400 x 220 pixels
- The background should preferably be transparent
- Save this logo in the correct directory in the format "*.png“ (Portable Network Graphic)

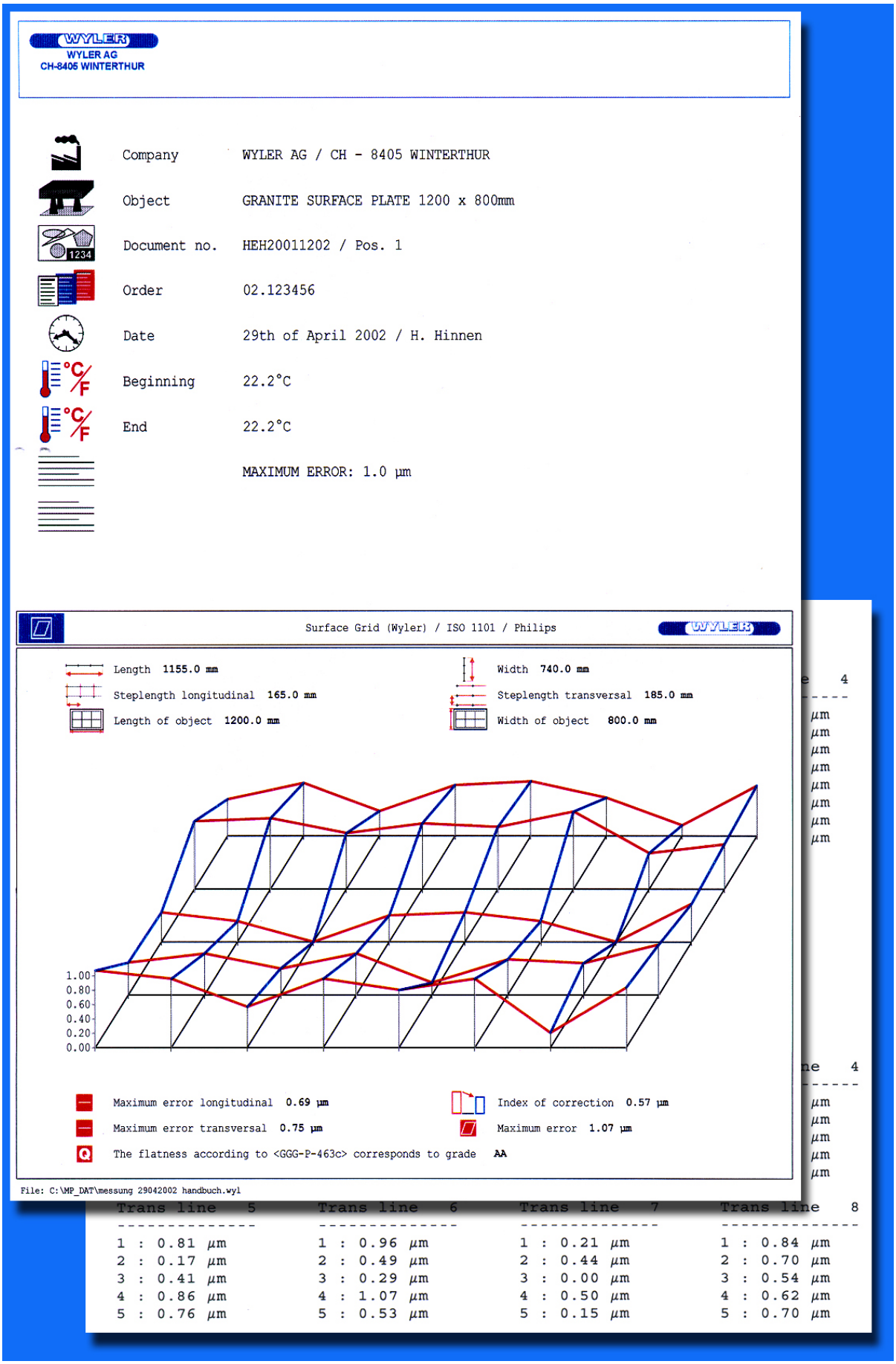
Using <Continue> [Space] the printer can be selected



Select printer and confirm with [OK] starts the printing, [Escape] will stop the procedure

The print out of the header sheet may look as follows: (Depending on the options chosen)

- First sheet with header information and graphical display.
- Data sheet with detailed numerical values of the individual measuring points



WYLER
WYLER AG
CH-8405 WINTERTHUR

Company	WYLER AG / CH - 8405 WINTERTHUR
Object	GRANITE SURFACE PLATE 1200 x 800mm
Document no.	HEH20011202 / Pos. 1
Order	02.123456
Date	29th of April 2002 / H. Hinnen
Beginning	22.2°C
End	22.2°C
	MAXIMUM ERROR: 1.0 µm

Surface Grid (Wyler) / ISO 1101 / Philips

Length 1155.0 mm
Steplength longitudinal 165.0 mm
Length of object 1200.0 mm
Width 740.0 mm
Steplength transversal 185.0 mm
Width of object 800.0 mm

1.00
0.80
0.60
0.40
0.20
0.00

Maximum error longitudinal 0.69 µm
Maximum error transversal 0.75 µm
Index of correction 0.57 µm
Maximum error 1.07 µm
The flatness according to <GGG-P-463c> corresponds to grade AA

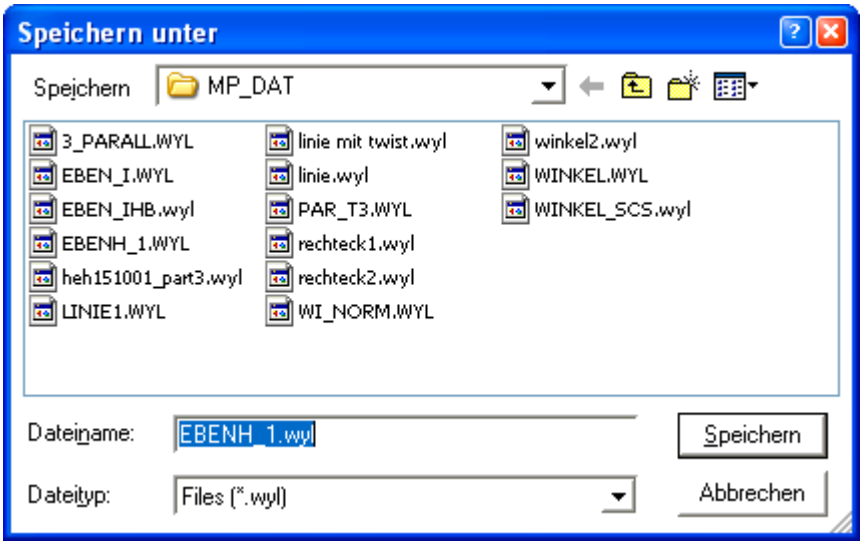
File: C:\MP_DAT\messung 29042002 handbuch.wyl

Trans line 5	Trans line 6	Trans line 7	Trans line 8
1 : 0.81 µm	1 : 0.96 µm	1 : 0.21 µm	1 : 0.84 µm
2 : 0.17 µm	2 : 0.49 µm	2 : 0.44 µm	2 : 0.70 µm
3 : 0.41 µm	3 : 0.29 µm	3 : 0.00 µm	3 : 0.54 µm
4 : 0.86 µm	4 : 1.07 µm	4 : 0.50 µm	4 : 0.62 µm
5 : 0.76 µm	5 : 0.53 µm	5 : 0.15 µm	5 : 0.70 µm

4.7.4 Export of Measuring Data in Unicode-Format

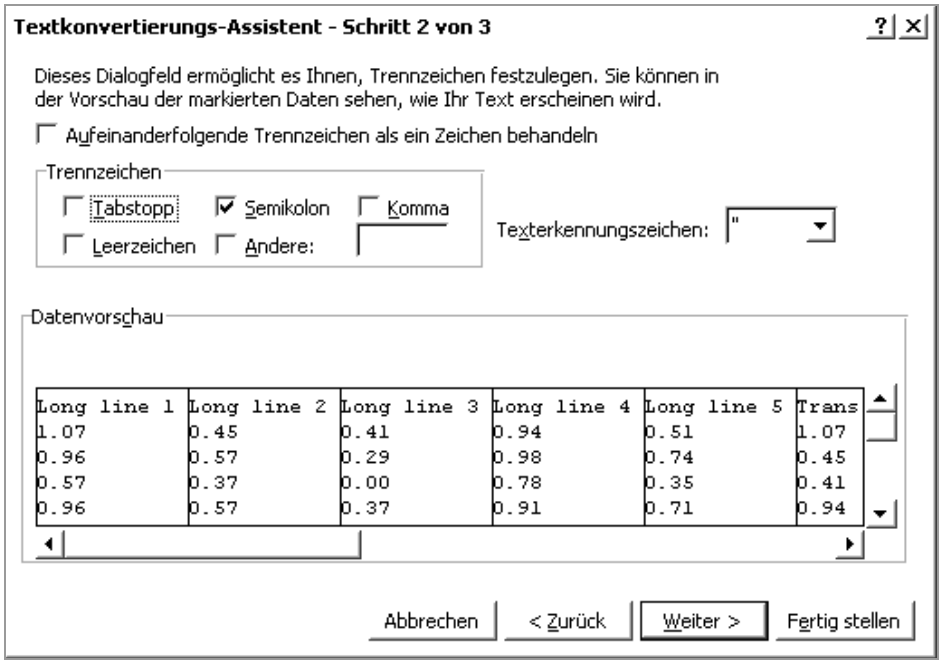
The values measured can be exported as a Unicode File and then imported in other applications, e.g. Microsoft EXCEL. The file is memorised in .txt format.

1st step EXPORT of measuring data



2nd step Import of Measuring Data in EXCEL:

Open the file "*.txt" from the directory where it has been memorised.

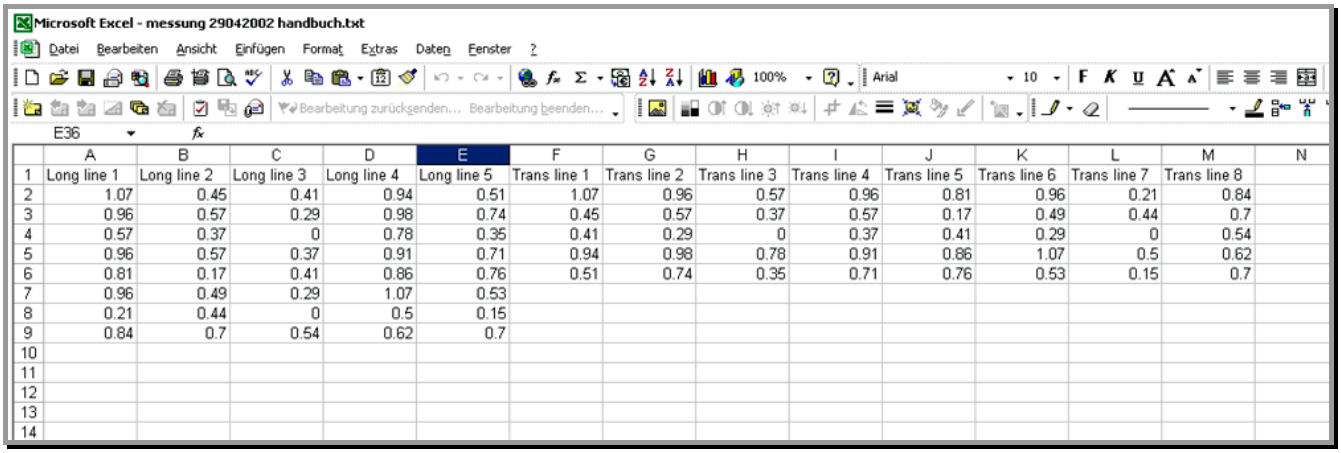


Select

<Semicolon>

(In the pre-view the measuring values are already visible in columns with header)

an then [**Finish**]



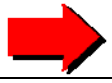
	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	Long line 1	Long line 2	Long line 3	Long line 4	Long line 5	Trans line 1	Trans line 2	Trans line 3	Trans line 4	Trans line 5	Trans line 6	Trans line 7	Trans line 8	
2	1.07	0.45	0.41	0.94	0.51	1.07	0.96	0.57	0.96	0.81	0.96	0.21	0.84	
3	0.96	0.57	0.29	0.98	0.74	0.45	0.57	0.37	0.57	0.17	0.49	0.44	0.7	
4	0.57	0.37	0	0.78	0.35	0.41	0.29	0	0.37	0.41	0.29	0	0.54	
5	0.96	0.57	0.37	0.91	0.71	0.94	0.98	0.78	0.91	0.86	1.07	0.5	0.62	
6	0.81	0.17	0.41	0.86	0.76	0.51	0.74	0.35	0.71	0.76	0.53	0.15	0.7	
7	0.96	0.49	0.29	1.07	0.53									
8	0.21	0.44	0	0.5	0.15									
9	0.84	0.7	0.54	0.62	0.7									
10														
11														
12														
13														
14														

Example:
Measurement of a Surface Plate 1200 x 800mm with

- 5 longitudinal lines
- 7 transversal lines

The imported measuring values can now be treated according to the requirements of the user.

4.7.5 Start measurement



Starting a measurement with the active measuring pattern

After definition of a measuring pattern (New measurement / Open measuring pattern / Measuring pattern new/change) the measurement can be started immediately by applying

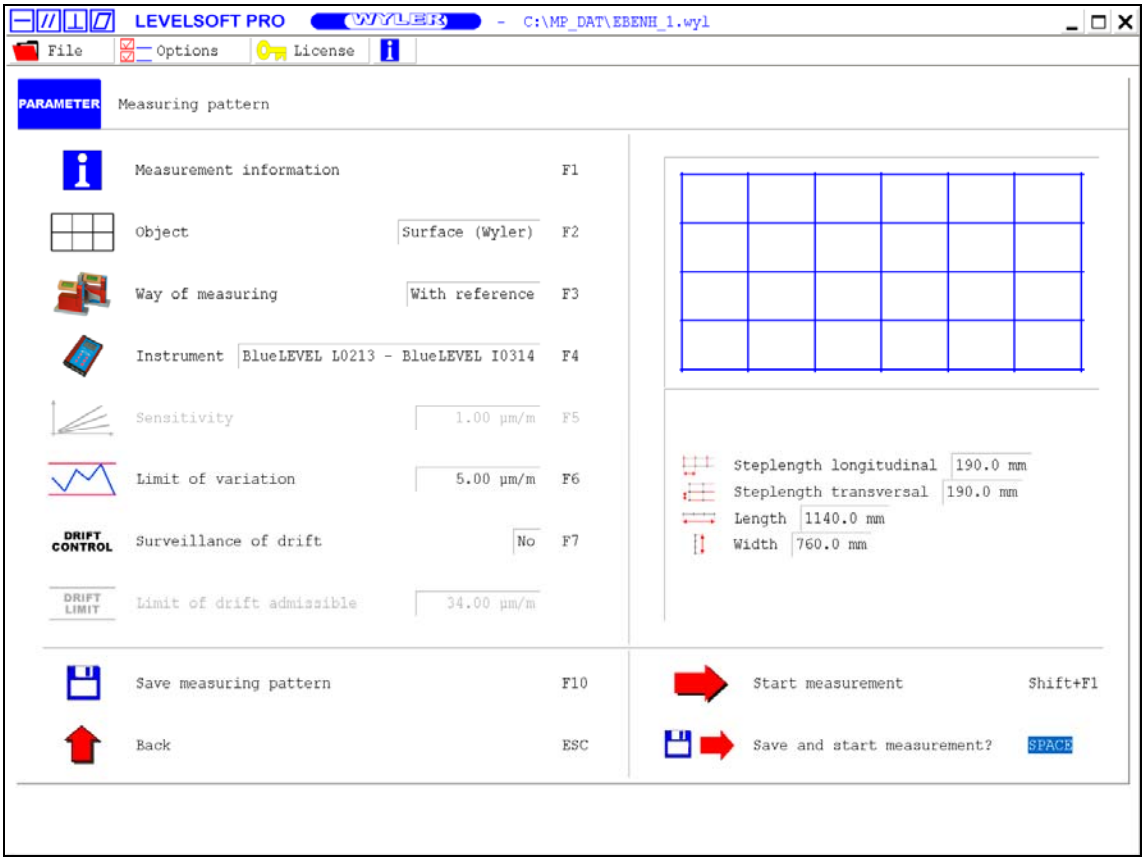
/ [F3]

in the header line. It is also possible to use the menu point “File / Start measurement”

- Create a new measuring pattern
- Use an existing measuring pattern and change it.

In the menu point “File / Measuring pattern new / Change” the configuration may be defined: The following parameters can be set (see below):

- Object
- Way of measuring (one instrument, two instruments etc.)
- Instrument (if not defined by system)
- Sensitivity (if not defined by system)
- Limit of variation
- Surveillance of drift
- Limit of drift admissible (if drift control is activated)



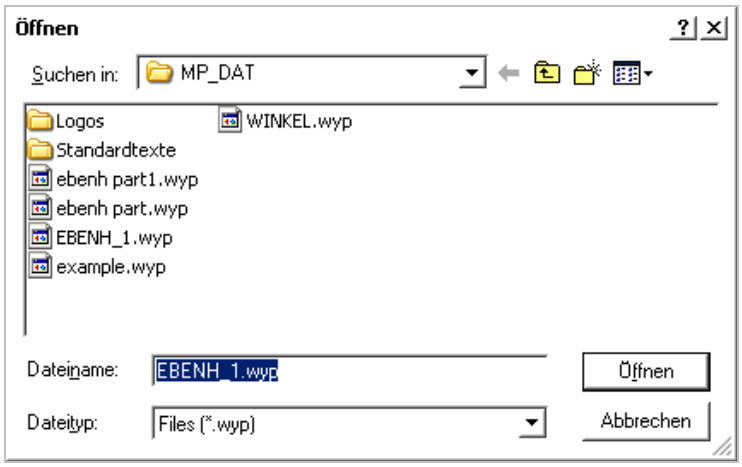
After finishing the measuring configuration the following possibilities exist:

- Save the configuration for later use as **measuring pattern with ending ".wyp"**
- Start a measurement **without saving as measuring pattern**
- Save the configuration as **measuring pattern with ending ".wyp"** and start the measurement

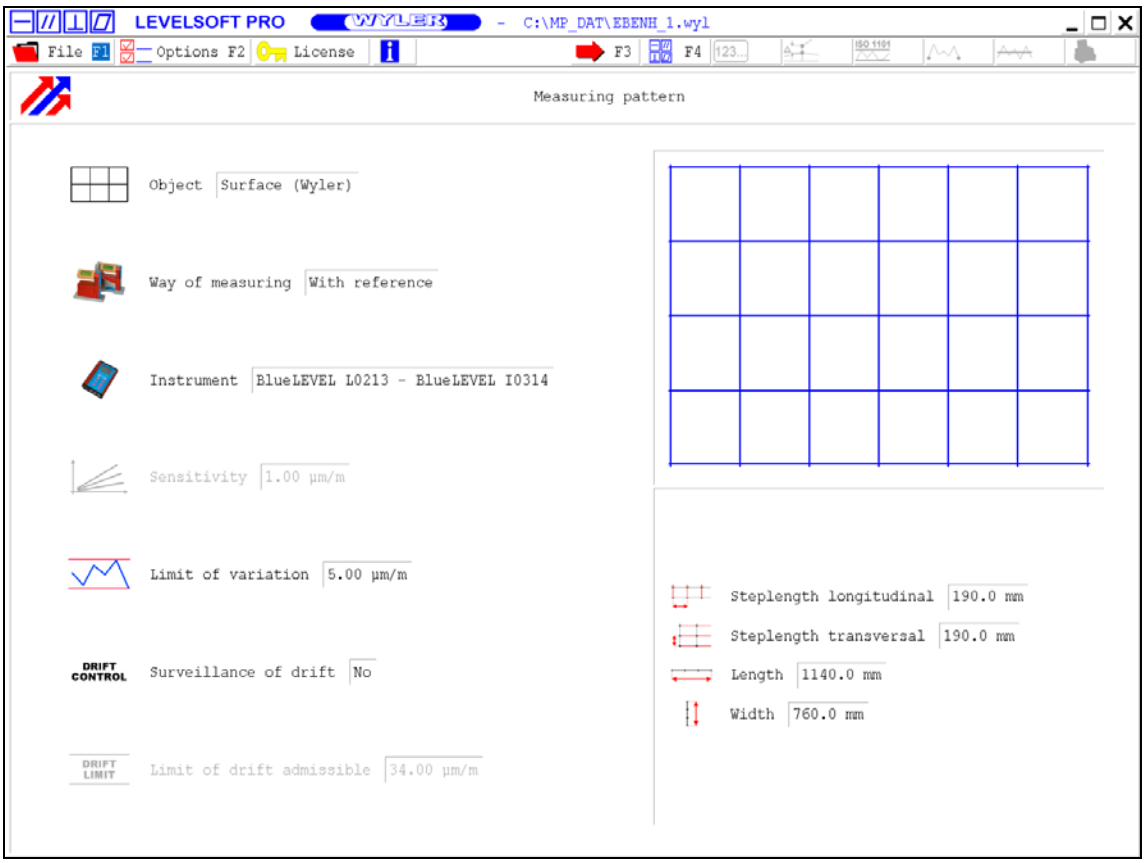
4.7.7 Load a measuring pattern

Open an existing measuring pattern with ending ".wyp" from a floppy or the hard disk.

When the menu point “Open measuring pattern” is activated the following dialog box is opened:



The file type is "*.wyp", which means all the measuring patterns saved as files are displayed. You can select the respective file and activate <Continue>. The selected measurement is displayed



After definition of a measuring pattern (New measurement / Open measuring pattern / Measuring pattern new/change) the measuring pattern may now be changed or the measurement can be started immediately by applying

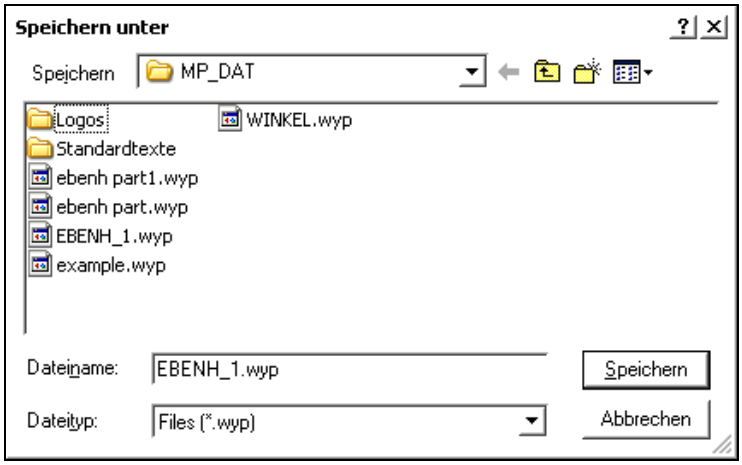
/ [F3]

in the header line. It is also possible to use the menu point “File / Start measurement”

4.7.8 Save a measuring pattern

Save the actual measuring pattern on a floppy or the hard disk. The ending will be ".wyp"

When the menu point “Save measuring pattern” is activated the following dialog box is opened:

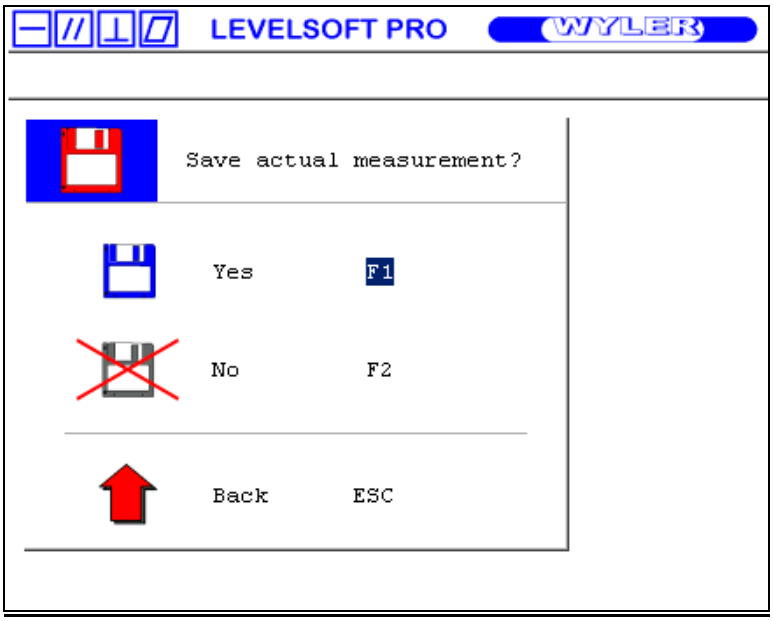


The file type is "*.wyp", which means all the measuring patterns saved as files are displayed. You can enter a new file name and activate <Continue>.

4.7.9 End Program

Terminate the program LEVELSOFT PRO

Before the closing of the software the following dialogue box appears to remind if all the measurements are saved etc.



4.7.10 Back

Back to the main menu

4.7.11 Change language

Change the language for using the software and the print out. These changes do not influence the measuring software as such

4.7.12 Change measuring unit

The measuring units can be set at any time according to the requirements. It is also possible for measurements already taken. The following options are possible:

- Choice of "metric". Inclination unit is "µm/m" and flatness error is "µm", dimensions and step length are in "mm"
- Choice of Imperial (Inch, sec. of arc) Inclination unit is "arc seconds" (e.g. sensitivity of instruments) and flatness error is "fractions of inch", dimensions and step length are in "inch"
- Choice of Imperial (Inch, Inch/10Inch) Inclination unit is "Inch/10Inch" (e.g. sensitivity of instruments) and flatness error is "fractions of inch", dimensions and step length are in "inch"

The selection is either by mouse click or by using the correct key

4.7.13 Change scale

SCALE

Change the size of the displayed graphic on the monitor and on the print out. The following options are possible:

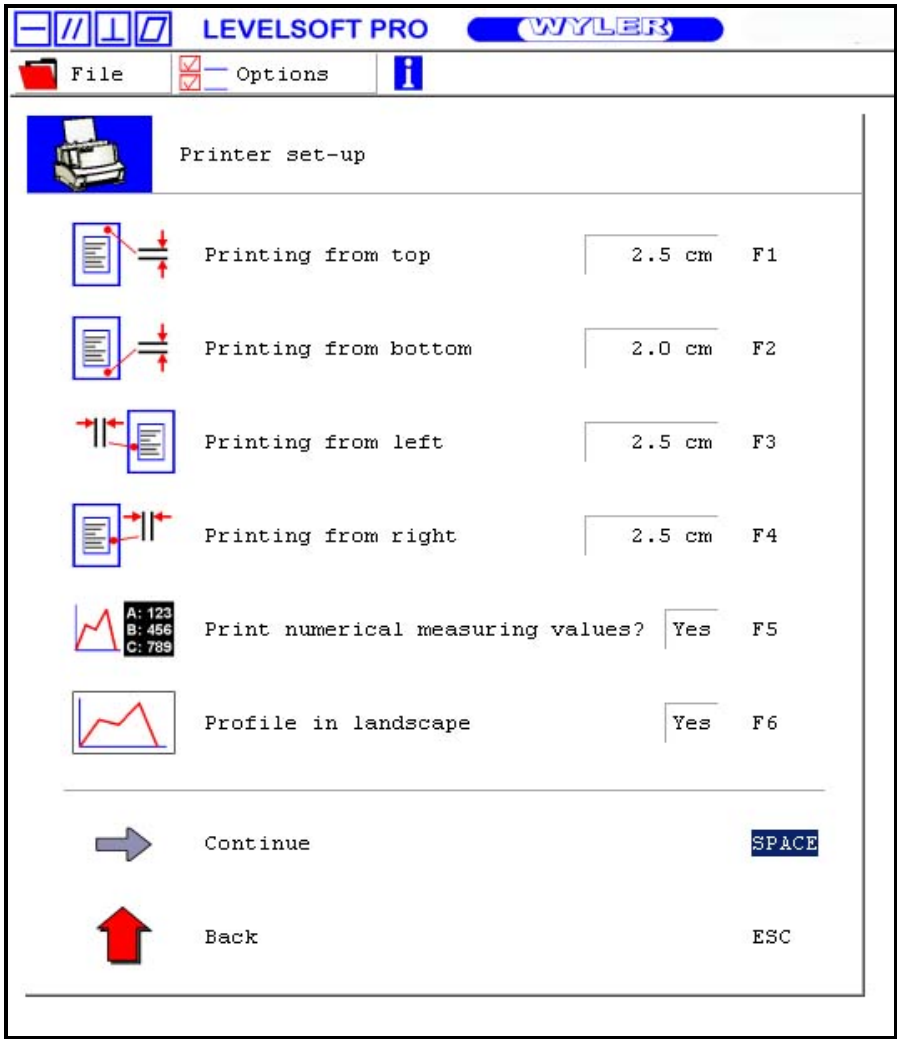
- Automatic, the display is always in the maximum possible resolution
- User defined, the user can adjust the display according to the requirements.

The selection is either by mouse click or by using the correct key

4.7.14 Set-up printing standard

Using the menu point "Options / Set-up printing standard" it is possible to adjust the print out according to the individual requirements (See below)

- Printing from top
- Printing from bottom
- Printing from left
- Printing from right
- Print numerical measuring values YES / NO
- Print profile in landscape (Paper format A4) YES / NO

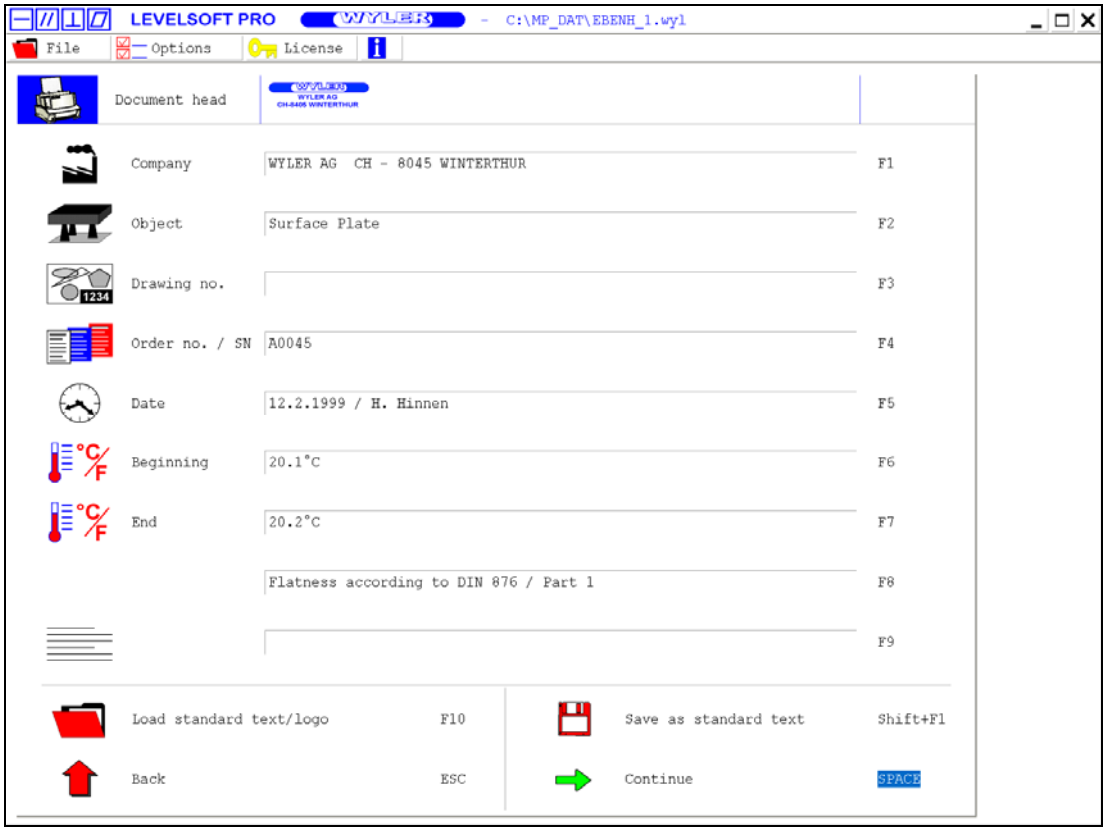


4.7.15 Change standard text

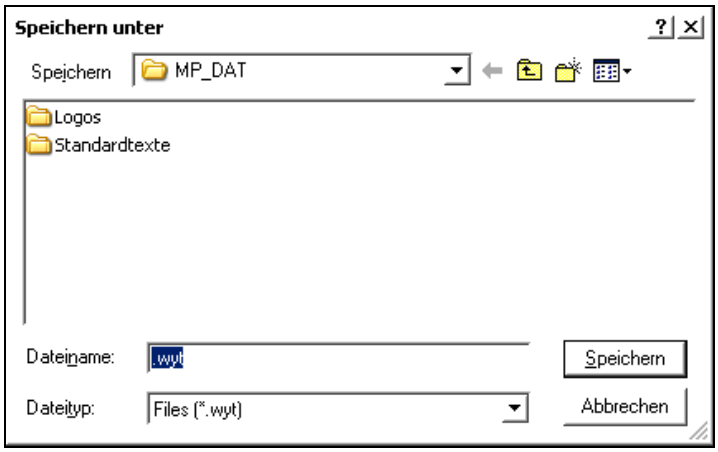
Entering the standard text for the **header sheet of the print out**

Using the menu point “Change standard text” it is possible to set a certain text which may be used regularly. This text **may be called any time when printing** is done.

Activating the menu point “Change standard text” the following display is seen where the respective information can be entered.



A modified text can be saved <Continue> / [Space] and if required at a later time opened again.



4.7.16 Adjust main window

Set up the windows size on the monitor of the application LEVELSOFT PRO. It is also possible to use the mouse for changing the size by simply pulling the corner of the window.

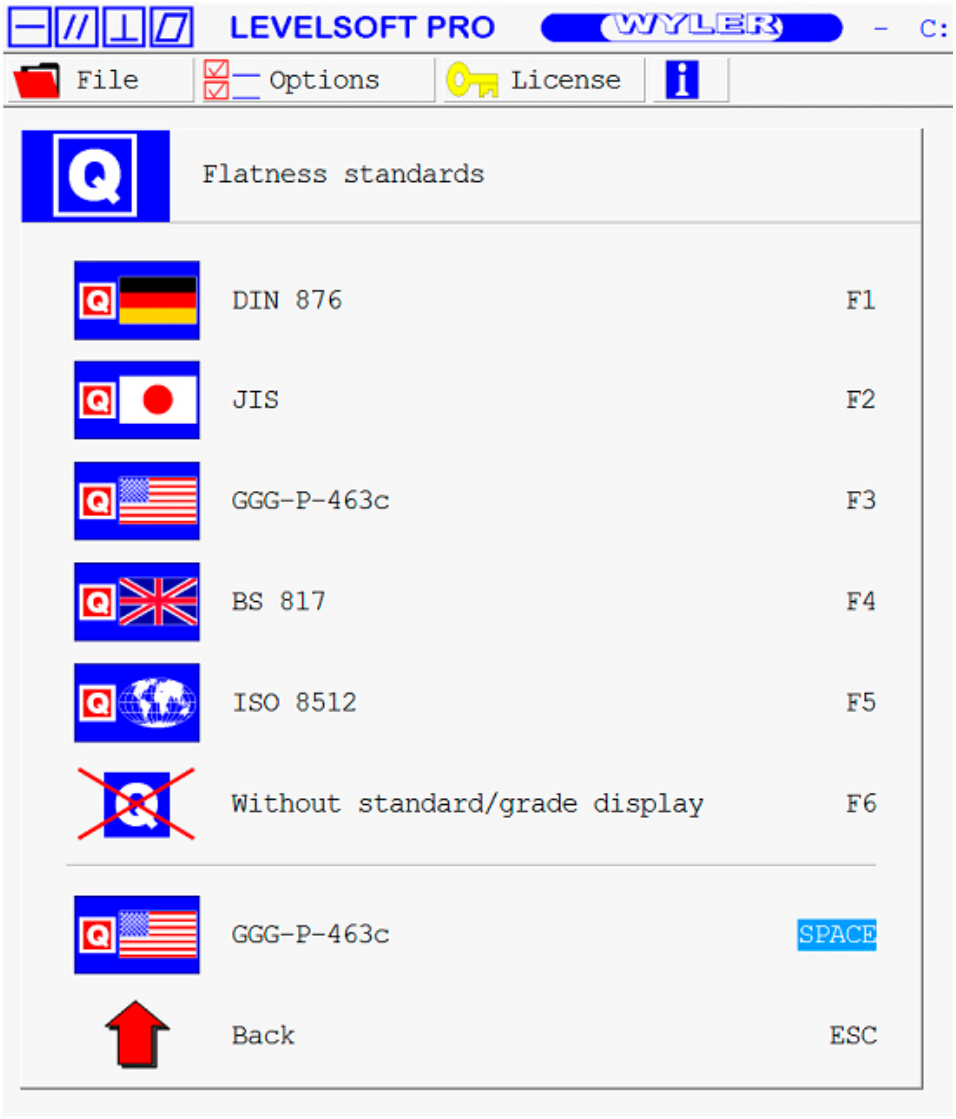
4.7.17 Change standard

With this option the required flatness standard mentioned on the print out with the effective quality of the measurement can be selected (respectively deactivated)

The following standards can be selected:

- **DIN 876**
- **JIS / Japanese Standard**
- **GGG-P-463c / US-Standard**
- **BS 817 / British Standard**
- **ISO 8512**

It is also possible to chose <Without standard / grade display> / [F5]
If this is selected no quality definition is on the print out



4.7.18 Back

Back to the main menu

4.7.19 Definition of a measuring pattern

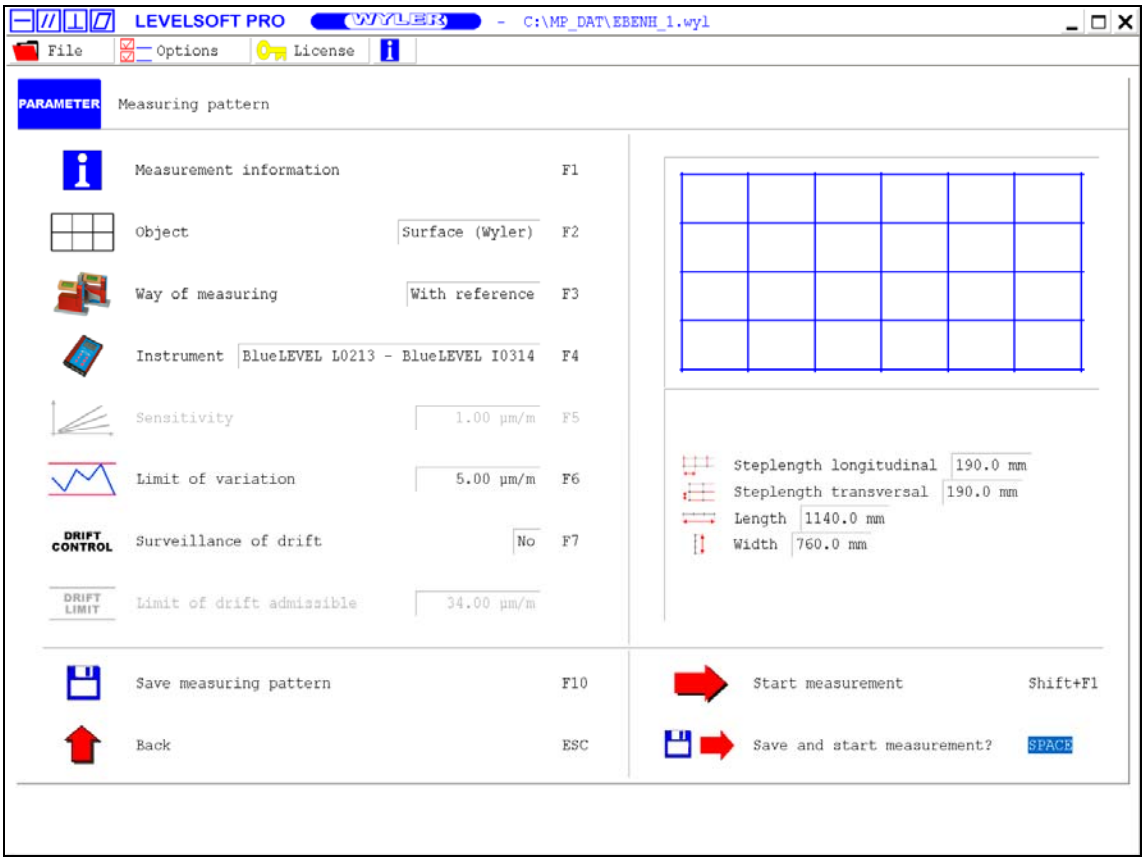
When a new measuring pattern should be created it is possible to either

- use an existing one and change it

  OR

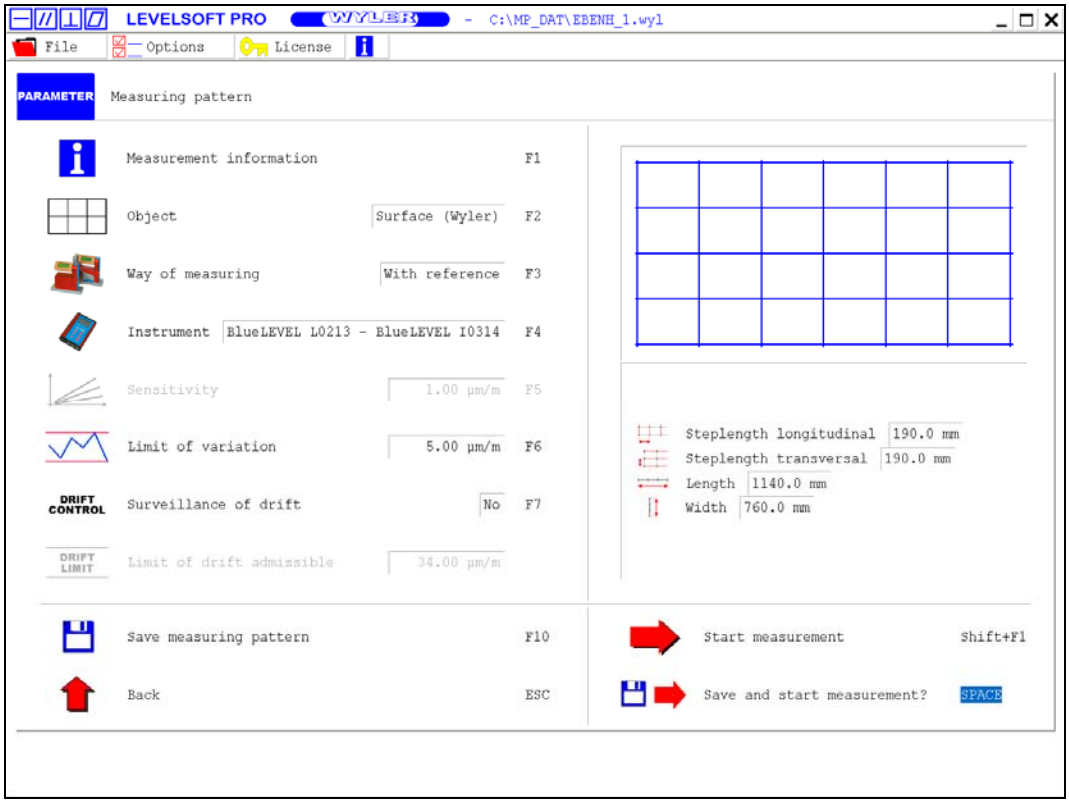
- create a completely new one from the scratches

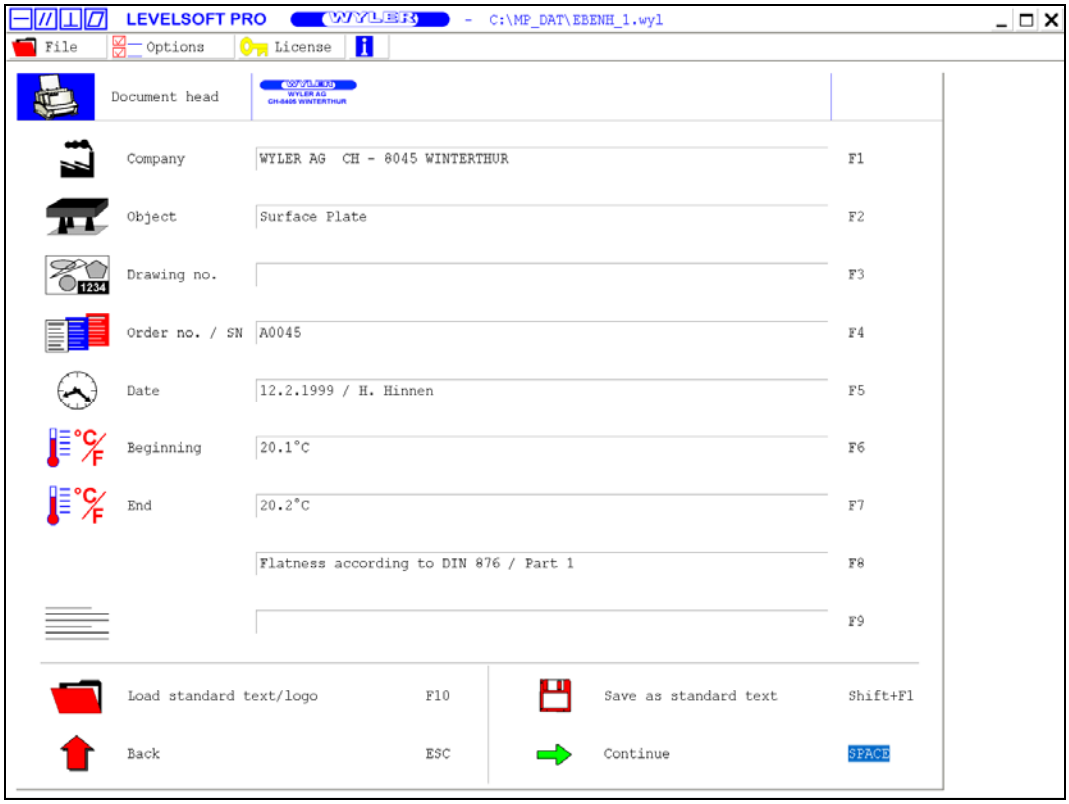
Open the menu point “File / Measuring pattern new / Change”. If earlier already a measurement was done the last used measuring pattern will automatically be opened. The name of the last measurement is seen with the ending “.wyp”.



4.7.19.1 Measurement information

Using the menu point “Measurement information” / [F1] will display the last used header information

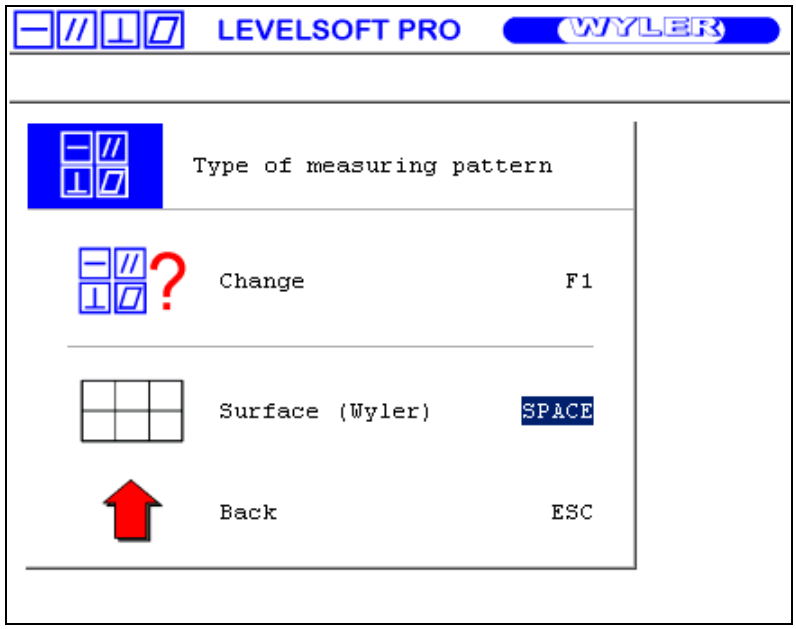




For additional information see Point 4.7.3 / “Print measurement”

4.7.19.2 Object

The object used in the last measurement is displayed as symbol and pronounced in the text area. e.g. "Surface WYLER". If this is to be changed or slightly altered the symbol must be clicked <Object> [F2] and a dialogue box appears:

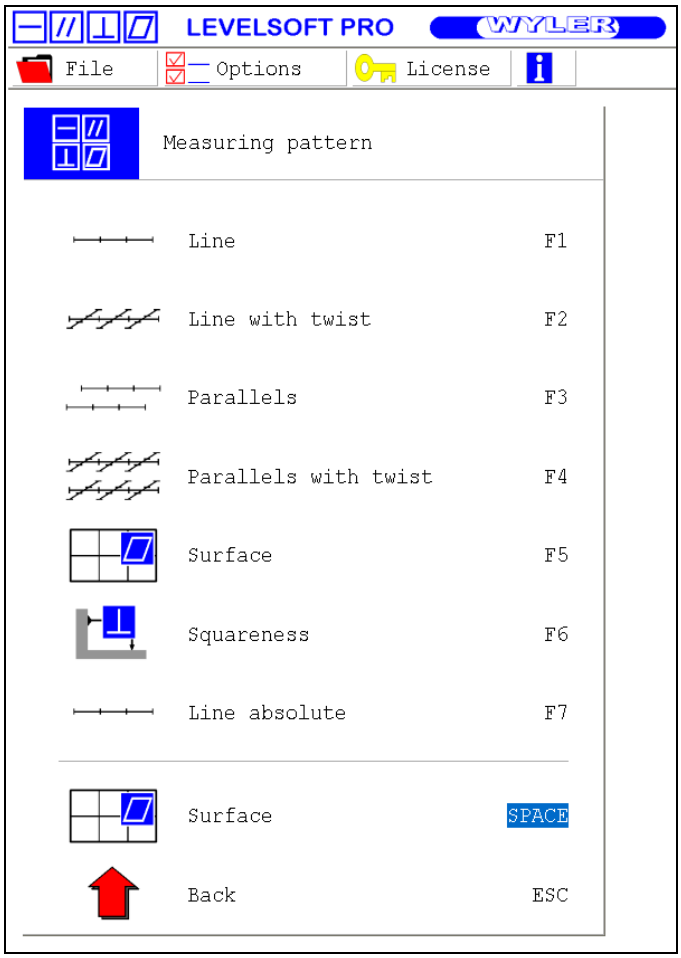


You can now

a) define a completely new object
   OR
b) use the existing object as is or change it slightly

In case a) {define **new measuring pattern**, complete new definition} / activate the menu point "Change".

The following dialogue box is seen with the listing of the possibilities of measuring patterns:



- **LINE**
  Measurement of lines, alignment according to “Endpoints”, “ISO 1101”, “Linear regression”

- **LINE WITH TWIST**
  Measurement of lines with twist. Alignment according to **End points** in X and Y direction, sets the start and the end point of the longitudinal line to the same level and also the start and end point of the first twist measurement to the same level.
  Alignment according to **ISO 1101**, smallest deviation considering all measuring points.
  Alignment according to **Linear regression** of the longitudinal line and of the first transversal line.

- **PARALLELS**
  Measurement of up to 3 parallels.
  Alignment according to the first parallel which can be aligned according to **End points** or according to **Linear regression**.
  Alignment according to ISO 1101 is not available for this pattern.

- **PARALLELS WITH TWIST**
  Measurement of up to 3 parallels with twist.
  Alignment according to the first parallel and to the first twist measurement according to **End points**.
  Alignment according to ISO 1101 and Linear regression are not available for this pattern.

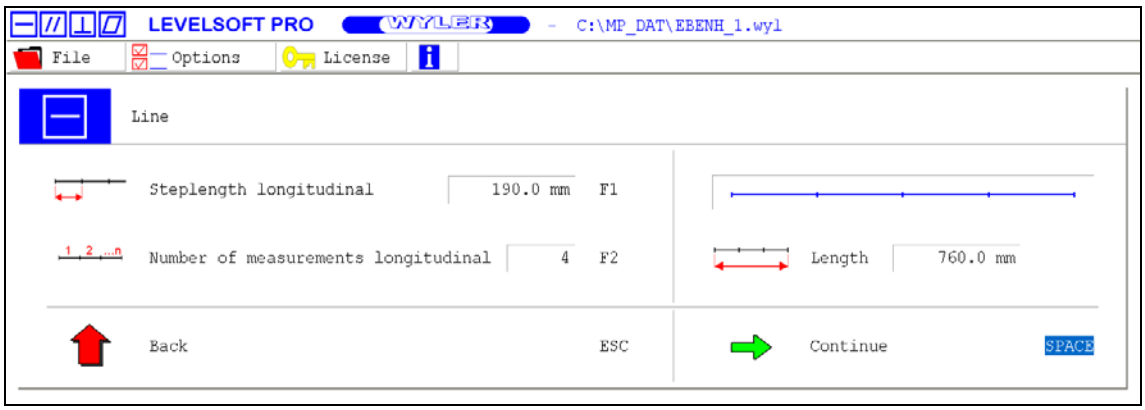
- **SURFACE (Flatness)**
  Measurement of surfaces, respectively flatness
  - SURFACE GRID (WYLER) =>Alignment “ISO 1101”
  - RECTANGLE=> “Endpoints”, (Alignment X & Y axis)
  - U-Jack => Alignment according to US-Governmental requirements GGG-P-463 c
  - Surface (Partial) => Flatness measurement of partial areas

- **SQUARENESS (Measurement of right angle)**
  Measurement of 90 deg. angles alignment according to “Endpoints”, “ISO 1101”, “Linear regression” Squareness of granite squares, alignment according to "WYLER / SCS“; “Endpoints” (Error calc. ISO1101)

- **LINE ABSOLUTE**
  Measurement of a line with absolute values

You can chose now the object you want to measure, e.g. "LINE"

In the following dialogue box the required step length and the number of steps can be entered. The results are immediately seen in the "ONLINE-MONITOR", upper right side. With this information the user can easily see the entered data.



Using <Continue> / [SPACE] the data is incorporated in the measuring pattern which will appear. In this menu the information is already visible. (See below)

In case b) {use the existing object as is or change it slightly} the object is confirmed by [SPACE]. If required the modification can take place:

- Step length
- Number of measurements
- Number of measurements longitudinal (Flatness measurement)
- Number of measurements transversal (Flatness measurement)
- etc.

The other steps are identical

4.7.19.3 Way of measuring

IMPORTANT:
For using the software LEVELSOFT PRO the measuring instruments must be updated to the latest firmware version. The measuring instruments of the NT series must be tagged with a serial number.

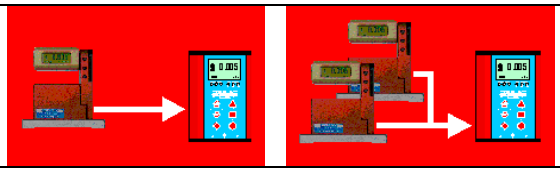
Normally the software LEVELSOFT PRO will recognise the interface connected provided that the latter is a WYLER product.

Basically there are the following options of interfaces:

I. The interface connected is a **BlueMETER** with or without wireless transmission module
II. The interface connected is a **LEVELMETER 2000**
III. The interface connected is a **LEVELMETER LIGHT**
IV. The interface connected is a **LEVELADAPTER 2000**

Procedure in case I)

The interface connected is a **BlueMETER** with of without wireless transmission module



Three options are possible:

- Instrument [**A**] for measurements with one instrument
- Instrument [**A - B**] for measurements with two instruments (differential measurement)
- Console input for manual input of the values by console

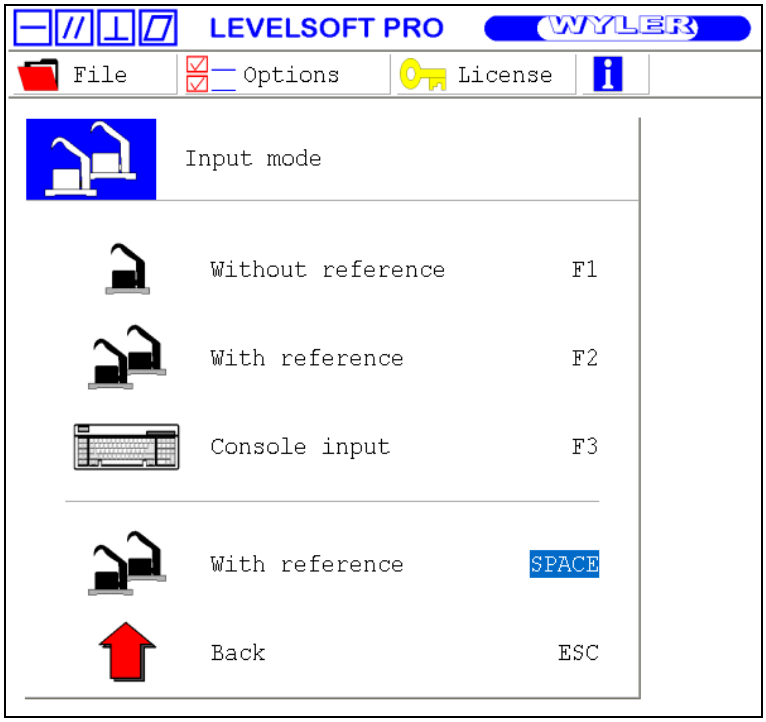
The instruments having been used for the last measurement are proposed again and, provided these are connected through the same interface and ready for use, the measurement can be performed with these instruments.

Next it must be defined whether

- measuring with one instrument
- measurement with two instruments (differential measurement)
- manual input of the values by console

is selected

Chose the required mode by clicking the correct icon or use the correct key. Using [SPACE] accepts the existing set-up.



After entering all the required data the measurement can be started.

IMPORTANT for console input:
When using the console input mode it is important to make the following settings

- The sensitivity of the instrument must be set to 1µm/m and the measured values must be entered in µm/m (e.g. using NIVELTRONIC instrument)
  OR
- Set the sensitivity same as the sensitivity of the instrument and enter the values in digit (e.g. Minilevel “classic” or Leveltronic “classic”.
  When using WYLER instruments 1 digit is corresponding to the sensitivity of the instrument.

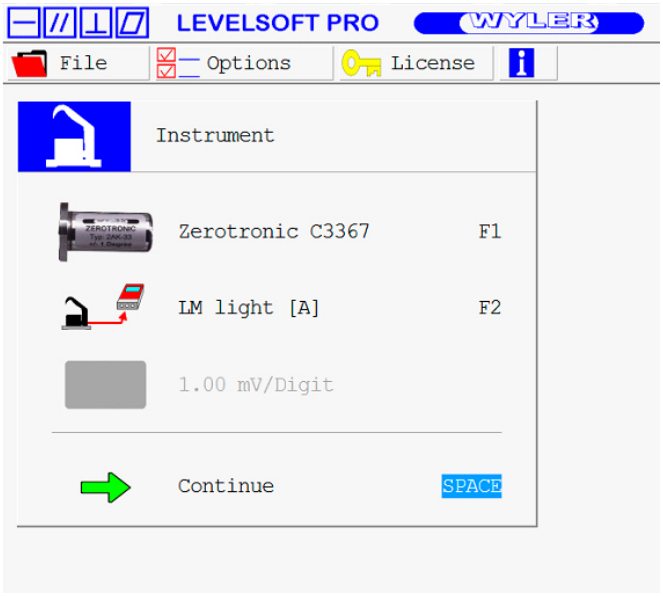
SELECT OTHER INSTRUMENTS OR ANOTHER INTERFACE

What to do,

- if in the field [F4] a wrong picture is displayed
- if in the field [F4] wrong instruments are listed
- if in the field [F4] a measuring instrument is missing
- when at the start of a measurement no measuring instrument is found

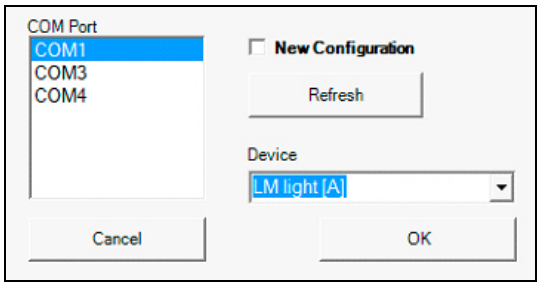
Connect the measuring instrument to the software.
If the picture to the left of the line [F4] does not correspond to the measuring instruments available or when LEVELSOFT PRO after unsuccessful initialisation displays the message "no instruments", the instruments available must be newly connected to the software.

Select [F4]. A dialogue box with the title "Measuring instrument" will appear

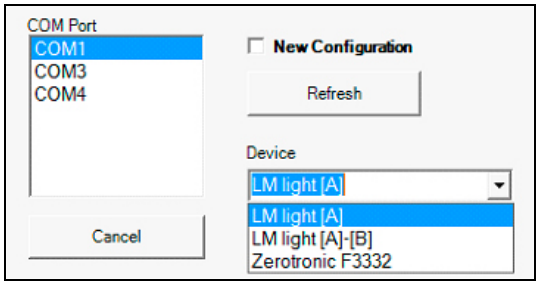


In this dialogue box select [F1].

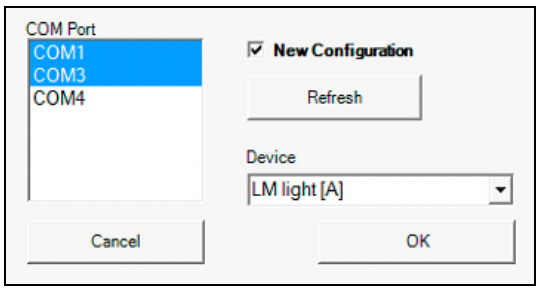
A new dialogue box with the title "Select Device" will appear.



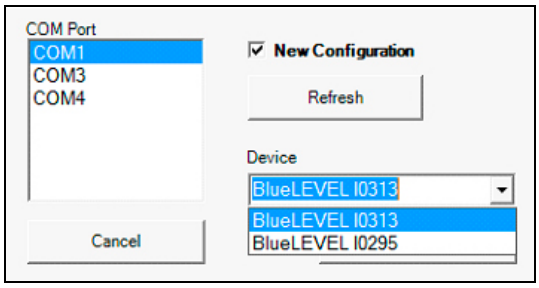
Open the pull down selection "Device"



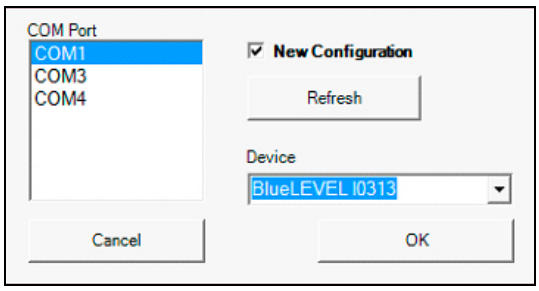
If the instrument available does not appear in the list this instrument must newly be connected. First select the COM port where the instruments are connected (you can even select more than one port, however, this will lead to a much longer searching time sequence). Tick the box "New Configuration" and click on the [Refresh] button.



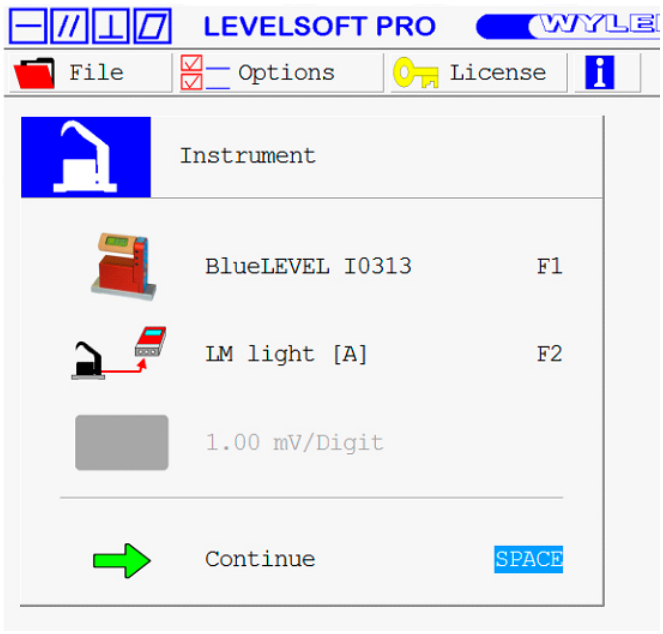
The instruments have been found and connected



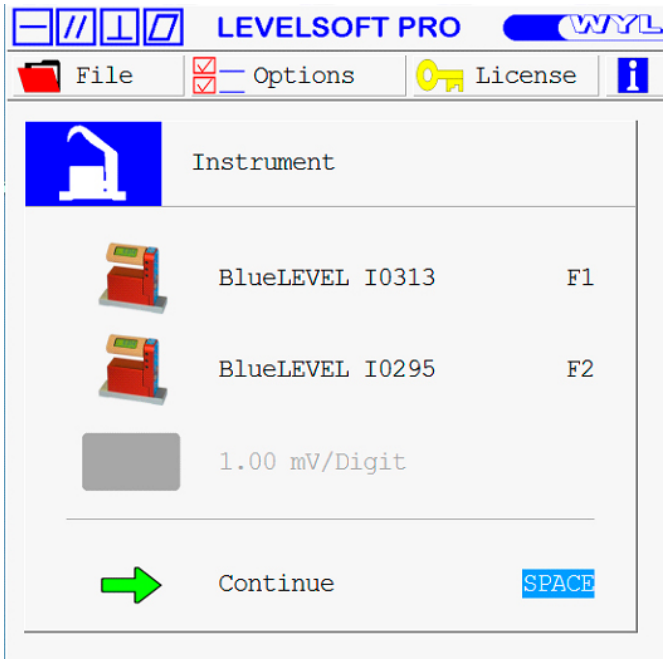
Select the instrument desired and confirm with OK.



The first measuring instrument is ready for the measurement.



Pressing [F2] opens the selection window again and the second measuring instrument can be selected.



With "continue" go to the window "Parameter - Measuring pattern"

The system is ready - with "start measurement" the measurement can now be performed.

Procedure in case II)

The interface is a **LEVELMETER 2000**

Three options are possible:

- Instrument [**A**] for measurements with one instrument
- Instrument [**A - B**] for measurements with two instruments (differential measurement)
- Console input for manual input of the values by console

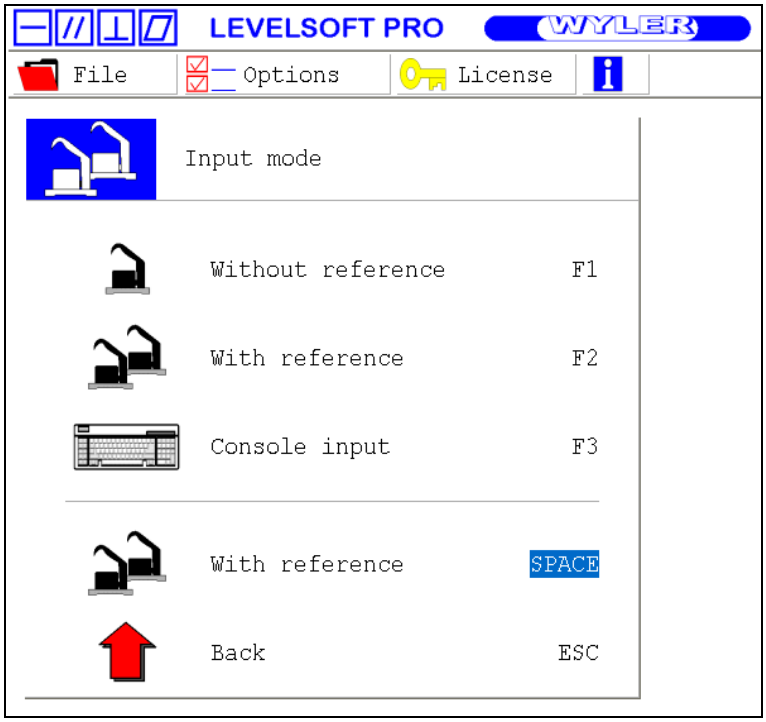
The instruments having been used for the last measurement are proposed again and, provided these are connected through the same interface and ready for use, the measurement can be performed with these instruments.

Next it must be defined whether

- measuring with one instrument
- measurement with two instruments (differential measurement)
- manual input of the values by console

is selected

Chose the required mode by clicking the correct icon
or use the correct key. Using [SPACE] accepts the existing set-up.



After entering all the required data the measurement can be started.

IMPORTANT for console input:
When using the console input mode it is important to make the following settings

- The sensitivity of the instrument must be set to 1µm/m and the measured values must be entered in µm/m (e.g. using NIVELTRONIC instrument)
  OR
- Set the sensitivity same as the sensitivity of the instrument and enter the values in digit (e.g. Minilevel “classic” or Leveltronic “classic”.
  When using WYLER instruments 1 digit is corresponding to the sensitivity of the instrument.

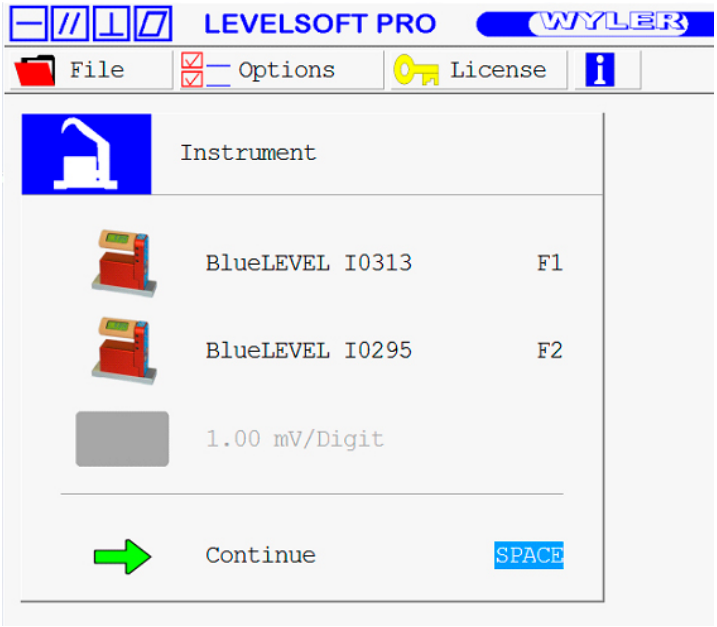
SELECT OTHER INSTRUMENTS OR ANOTHER INTERFACE

What to do,

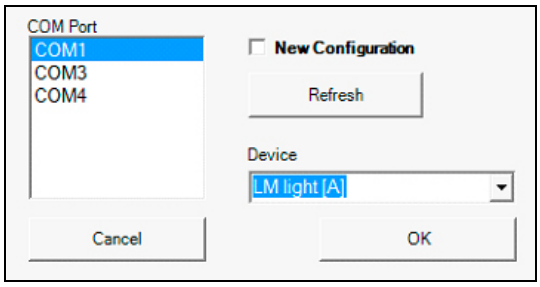
- if in the field [F4] a wrong picture is displayed
- if in the field [F4] wrong instruments are listed
- if in the field [F4] a measuring instrument is missing
- when at the start of a measurement no measuring instrument is found

Connect the measuring instrument to the software.
If the picture to the left of the line [F4] does not correspond to the measuring instruments available or when LEVELSOFT PRO after unsuccessful initialisation displays the message "no instruments", the instruments available must be newly connected to the software.

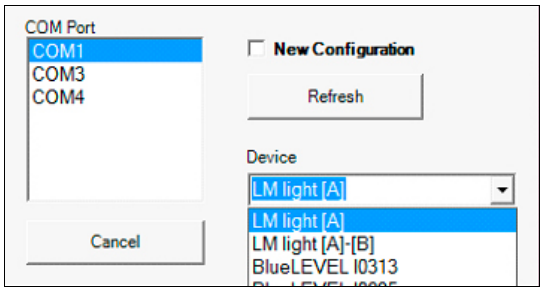
Select [F4]. A dialogue box with the title "Measuring instrument" will appear



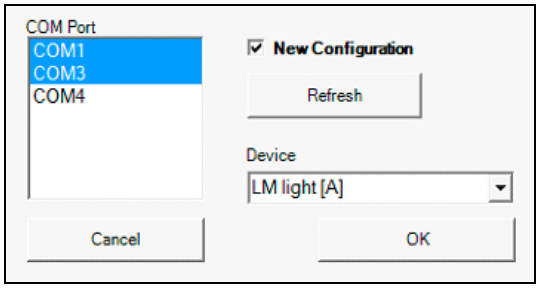
In this dialogue box select [F1].



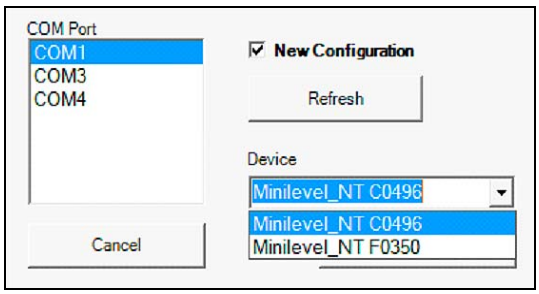
A new dialogue box with the title "Select Device" will appear.



Open the pull down selection "Device"

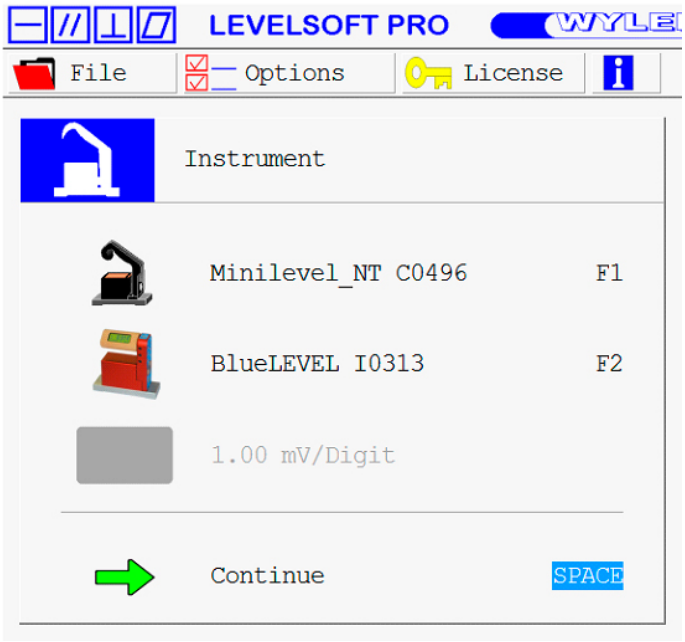


If the instrument available does not appear in the list this instrument must newly be connected. First select the COM port where the instruments are connected (you can even select more than one port, however, this will lead to a much longer searching time sequence). Tick the box "New Configuration" and click on the [Refresh] button.



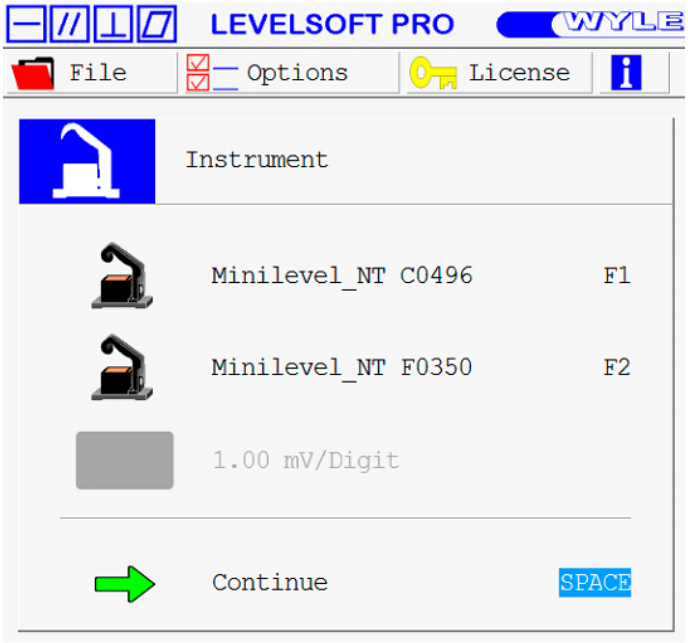
The instruments have been found and connected

Select the instrument desired and confirm with OK.



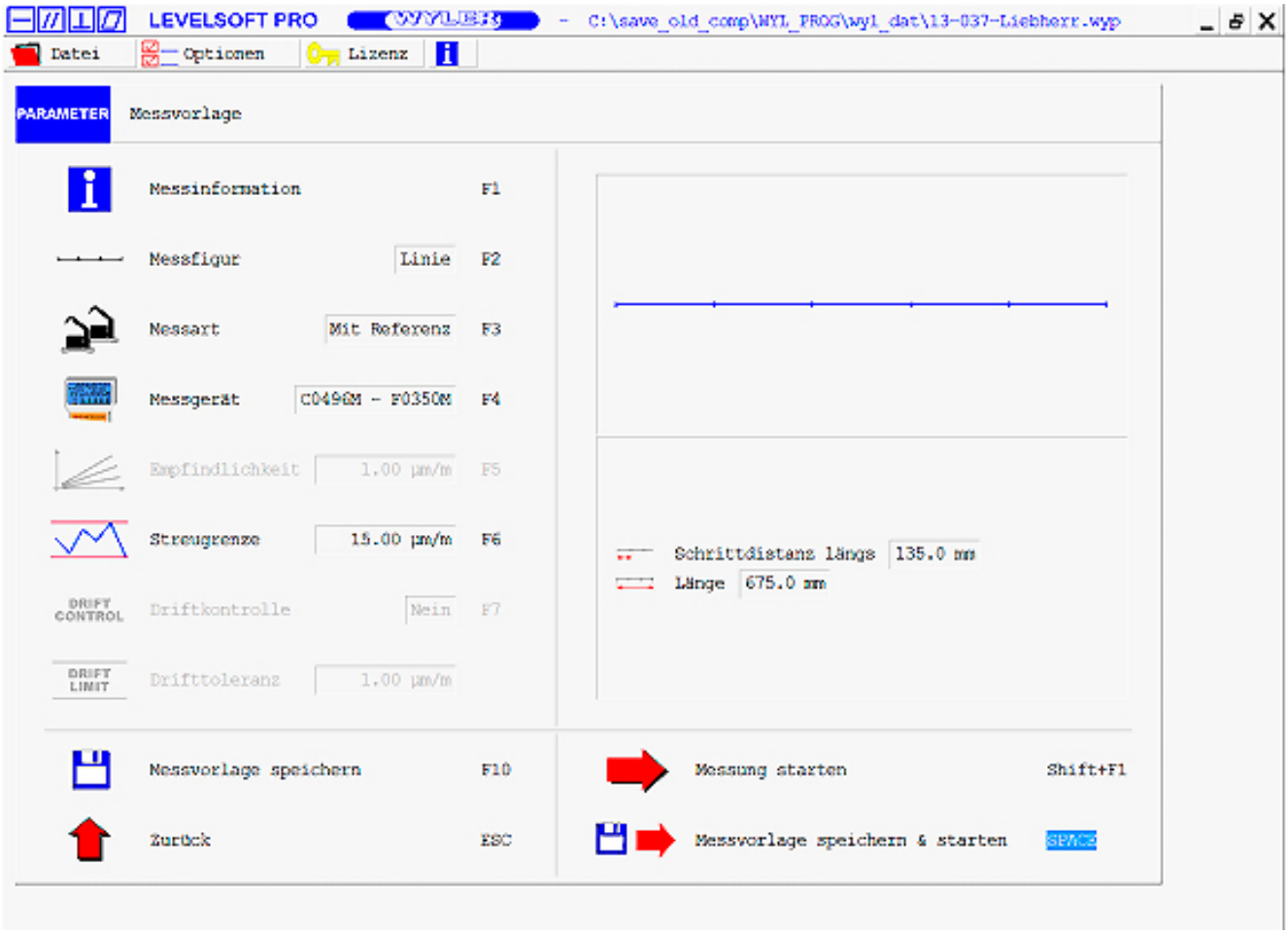
The measuring instrument is now listed in the window.

Pressing [F2] opens the selection window again and the second measuring instrument can be selected.



Both measuring instruments are listed

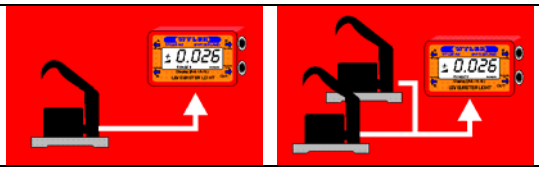
With "continue" go to the window "Parameter - Measuring pattern"



The instruments are listed with their respective serial numbers, the LEVELMETER 2000 is shown as a picture, the system is ready for the measurement.

Procedure in case III)

The interface is a **LEVELMETER LIGHT**



Three options are possible:

- Instrument [**A**] for measurements with one instrument
- Instrument [**A - B**] for measurements with two instruments (differential measurement)
- Console input for manual input of the values by console

The instruments having been used for the last measurement are proposed again and, provided these are connected through the same interface and ready for use, the measurement can be performed with these instruments.

2 instruments = @LL00d

1 instrument = @LL00s

Next it must be defined whether

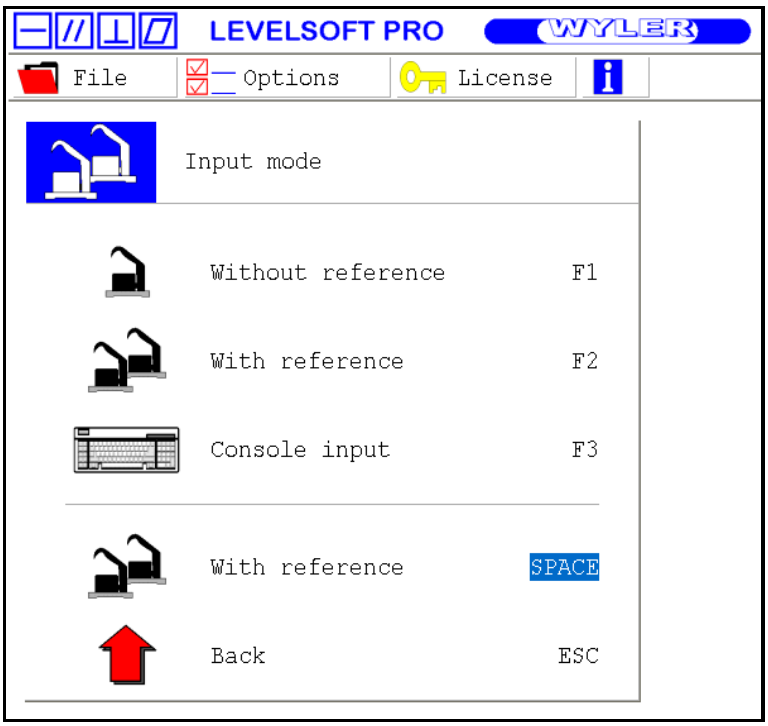
- measuring with one instrument
- measurement with two instruments (differential measurement)
- manual input of the values by console

is selected

Select the reading mode with which you intend to measure the measuring object by clicking on the respective pictogram or with the function key attributed. With [SPACE] the last used reading mode can be adopted. **Attention**! The reading mode must coincide with the "Selection Measuring instrument" (A) (@LL00s) or (A-B) (@LL00d).

The instruments having been used for the last measurement are proposed again and, provided these are connected through the same interface and ready for use, the measurement can be performed with these instruments.

Attention! The LEVELMETER LIGHT cannot identify the Serial Numbers of the instruments connected and pass them on to the software LEVELSOFT PRO. The LEVELMETER LIGHT cannot be switched between measuring with one instrument and measuring with two instruments by the software. On the screen the option (A) will be shown as @LL00s the option (A-B) as @LL00d. If the selection is correct LEVELSOFT PRO can, however, detect whether the set-up is connected accordingly with 1 measuring instrument for option (A) or 2 measuring instruments for option (A-B). The correct connection of the instruments to the LEVELMETER LIGHT, the measuring instrument to port A and the reference instrument to port B is in the responsibility of the user.



After entering all the required data the measurement can be started.

IMPORTANT for console input:
When using the console input mode it is important to make the following settings

- The sensitivity of the instrument must be set to 1µm/m and the measured values must be entered in µm/m (e.g. using NIVELTRONIC instrument)
  OR
- Set the sensitivity same as the sensitivity of the instrument and enter the values in digit (e.g. Minilevel “classic” or Leveltronic “classic”.
  When using WYLER instruments 1 digit is corresponding to the sensitivity of the instrument.

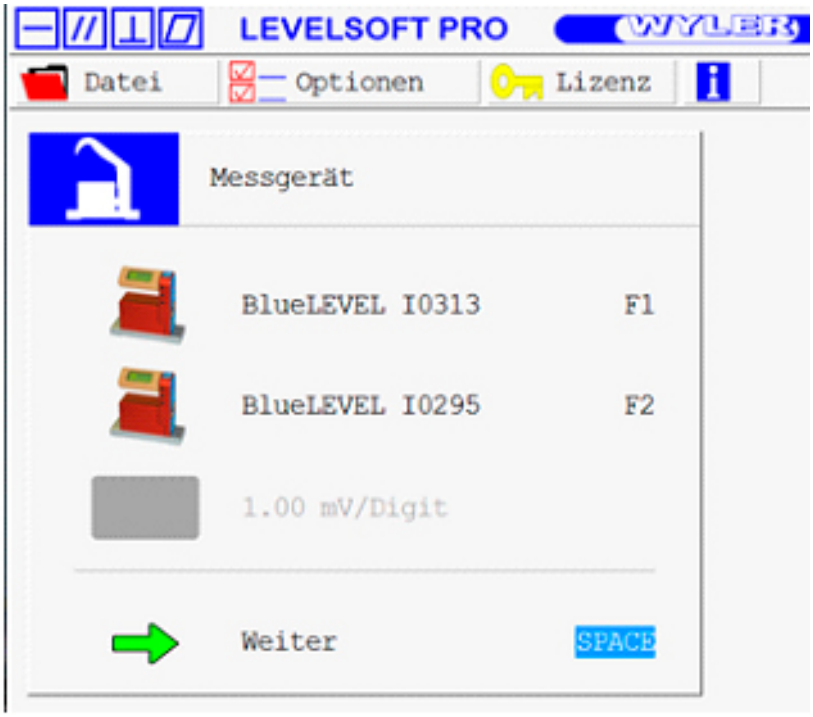
SELECT OTHER INSTRUMENTS OR ANOTHER INTERFACE

What to do,

- if in the field [F4] a wrong picture is displayed
- if in the field [F4] wrong instruments are listed
- if in the field [F4] a measuring instrument is missing
- when at the start of a measurement no measuring instrument is found

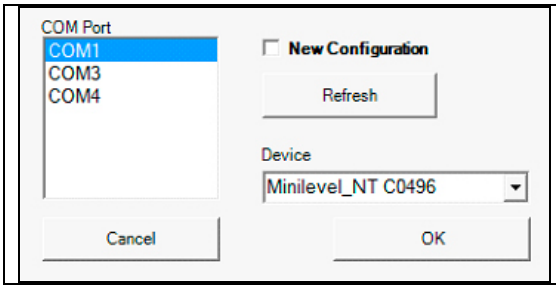
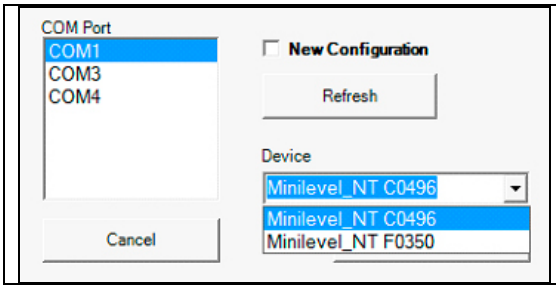
Connect the measuring instrument to the software.
If the picture to the left of the line [F4] does not correspond to the measuring instruments available or when LEVELSOFT PRO after unsuccessful initialisation displays the message "no instruments", the instruments available must be newly connected to the software.

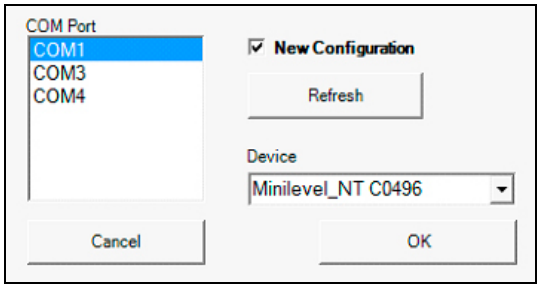
Select [F4]. A dialogue box with the title "Measuring instrument" will appear

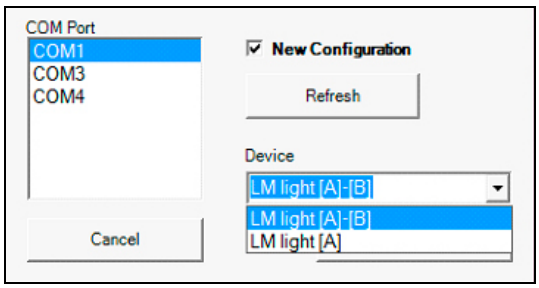


In this dialogue box select [F1] ([F2] will not provide a connection for LEVELMETER LIGHT or BLUEMETER LIGHT

A new dialogue box with the title "Select Device" will appear.

		Open the pull down selection "Device"
		If the instrument available does not appear in the list this instrument must newly be connected. First select the COM port where the instruments are connected (you can even select more than one port, however, this will lead to a much longer searching time sequence). Tick the box "New Configuration" and click on the [Refresh] button.

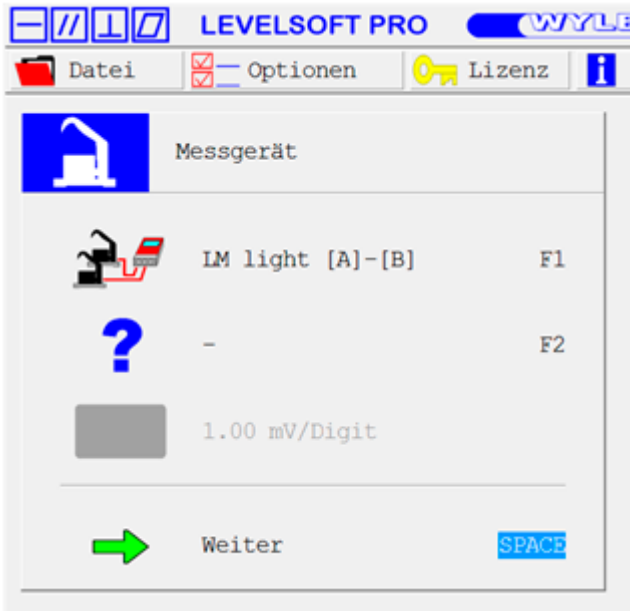




The LEVELMETER LIGHT has been detected.
Attention! This instrument is listed twice as you have to make the decision

- for one measuring instrument [A
  or
- for differential measurement with two measuring instruments [A] – [B]

already at this stage. Continue with OK.

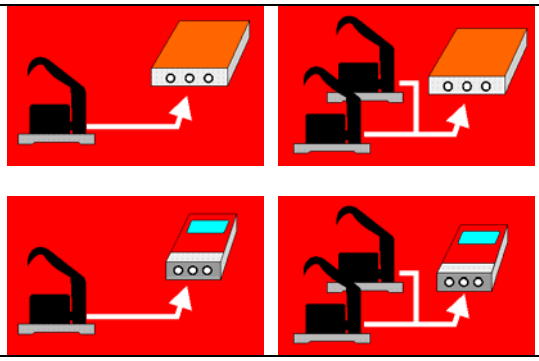


The instrument selected is shown in the dialogue box "measuring instrument". ([F2] cannot be used.)
Confirm with "continue".

The interface is shown as a picture, for differential measurement with the identification @LL00d with one only instrument with @LL00s. The selection at [F3] must be coincident with the selection at [F4].
The measurement can now be started.

Procedure in case IV)

The interface is a **LEVELADAPTER 2000** suitable for the connection of instruments with an analogue measuring signal



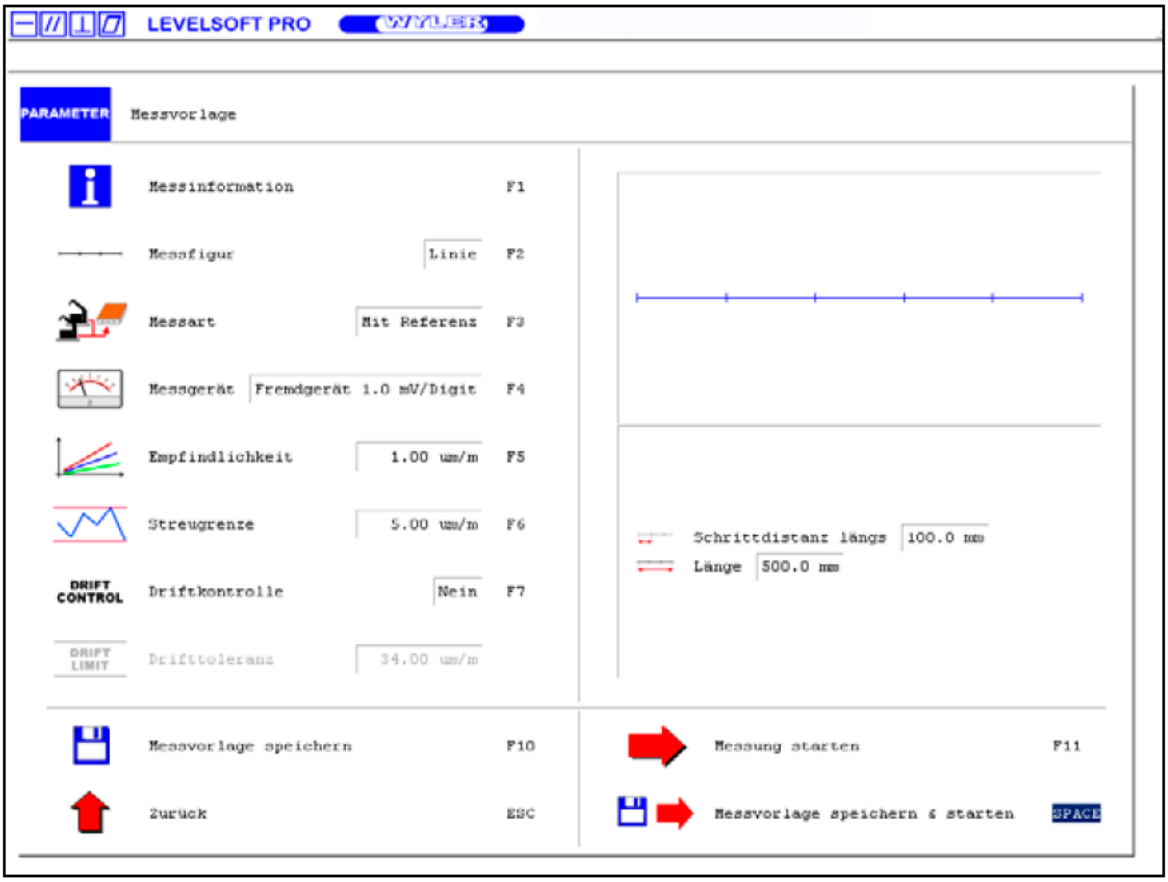
The following options are possible:

- Instrument[**A**] --> LA2000 --> PC — for measurements with one instrument and LEVELADAPTER 2000
- Instrument [A - B] --> LA2000 --> PC — for measurements with two instruments and LEVELADAPTER 2000
- Instrument [A] --> LM25 --> LA2000 --> PC — for measurements with one instrument, and Levelmeter 25, LEVELADAPTER 2000
- Instrument [A - B] --> LM25 --> LA2000 --> PC — for measurements with two instruments and Levelmeter 25, LEVELADAPTER 2000
- Console input — for manual input of the values by console

The instruments having been used for the last measurement are proposed again and, provided these are connected through the same interface and ready for use, the measurement can be performed with these instruments.

Attention! The LEVELADAPTER 2000 cannot identify the serial number of the instruments connected and transmit it to LEVELSOFT PRO. The LEVELADAPTER 2000 can **NOT** be switched between measuring with one instrument and measuring with two instruments by LEVELSOFT PRO. Therefore it is inevitable to select it as (A) or (A-B). On the screen the option (A) will be listed as LA2000 (A) the option (A-B) as LA2000 (A) - (B). LEVELSOFT PRO can also NOT detect whether the measuring instruments are connected correctly and whether the correct choice (A or A-B) has been made, this remains in the responsibility of the user.

Select the measuring mode with which you intend to measure the object by clicking on the correct icon or use the correct key. Using [SPACE] accepts the existing set-up.



IMPORTANT for the manual entry (e.g. when no instruments are connected to the PC)**:**
When entering the measuring data manually using the keyboard, it is important

- that the sensitivity is set to 1 µm/m and the measuring value is entered in µm/m (e.g. NIVELTRONIC instruments)
  OR
- that the sensitivity is adjusted to the sensitivity of the instrument and that the measuring data are entered in digits (e.g. for MINILEVEL "classic" or LEVELTRONIC "classic"). With WYLER instruments 1 digit (least count of the display) corresponds to the sensitivity of the measuring instrument.

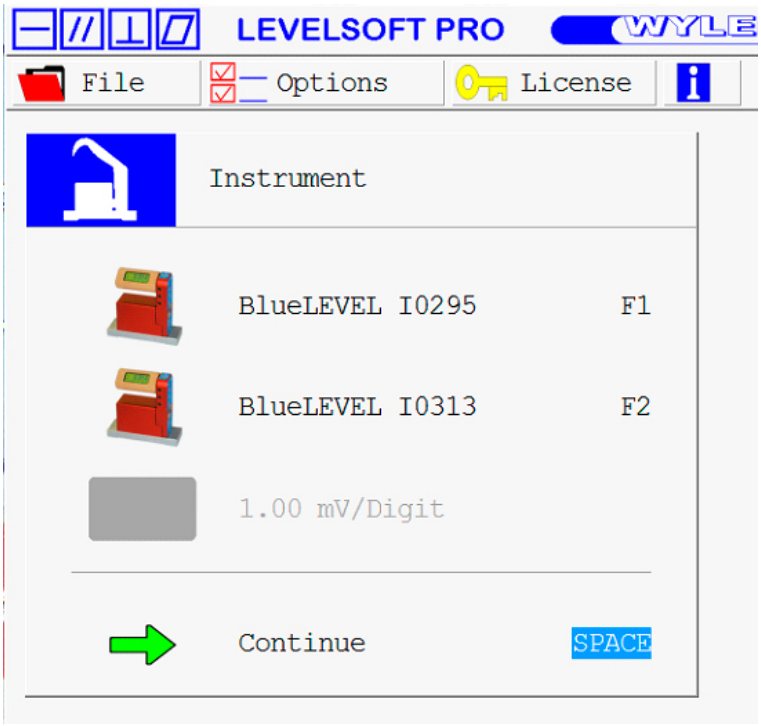
SELECT OTHER INSTRUMENTS OR ANOTHER INTERFACE

What to do,

- if in the field [F4] a wrong picture is displayed
- if in the field [F4] wrong instruments are listed
- if in the field [F4] a measuring instrument is missing
- when at the start of a measurement no measuring instrument is found

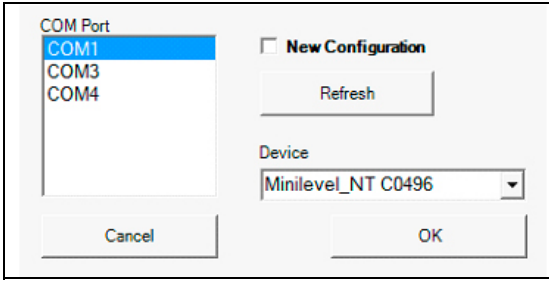
Connect the measuring instrument to the software.
If the picture to the left of the line [F4] does not correspond to the measuring instruments available or when LEVELSOFT PRO after unsuccessful initialisation displays the message "no instruments", the instruments available must be newly connected to the software.

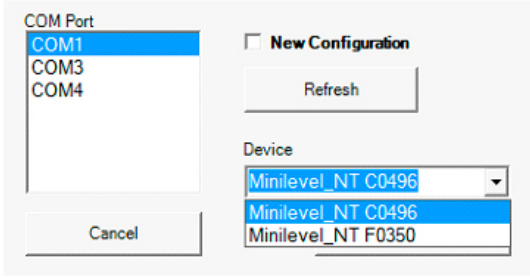
Select [F4]. A dialogue box with the title "Measuring instrument" will appear

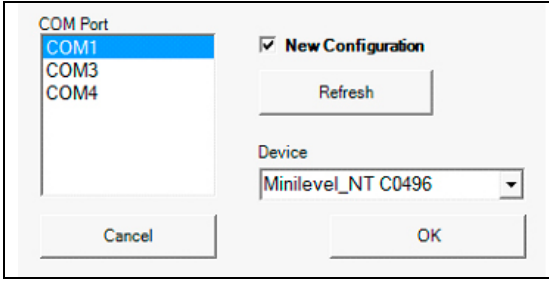


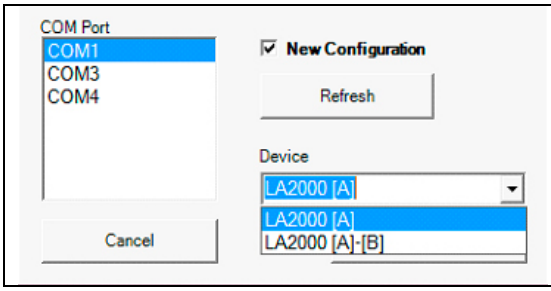
In this dialogue box select [F1] ([F2] will not provide a connection for the LEVELADAPTER 2000)

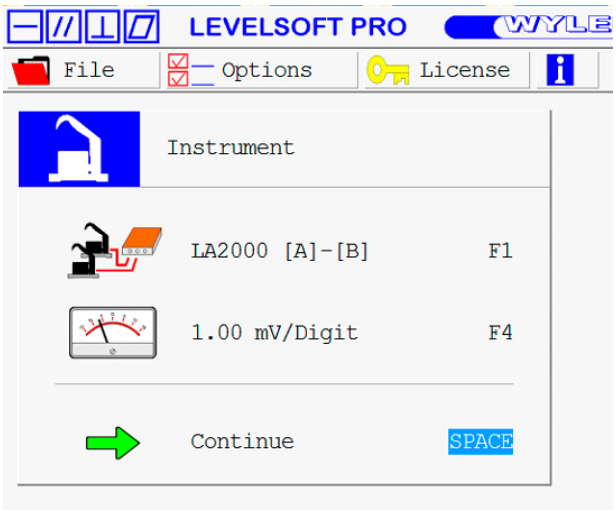
A new dialogue box with the title "Select Device" will appear.

	Open the pull down selection "Device"

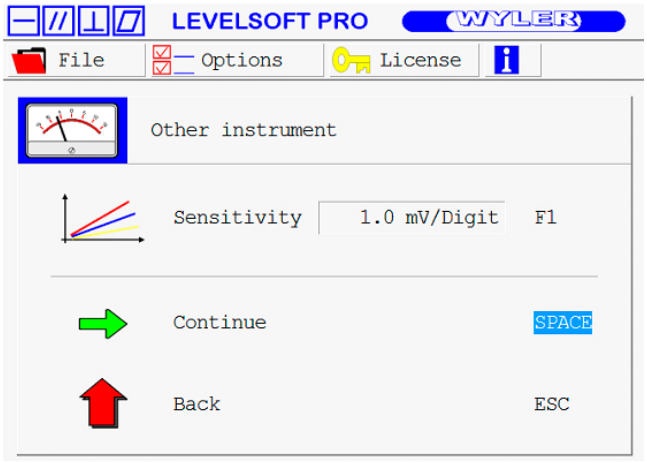
	If the instrument available does not appear in the list this instrument must newly be connected. First select the COM port where the instruments are connected (you can even select more than one port, however, this will lead to a much longer searching time sequence). Tick the box "New Configuration" and click on the [Refresh] button.

	The LEVELADAPTER has been found and connected. Attention! The LEVELADAPTER 2000 is listed twice. For differential measurement select (A) - (B). For measurements with on instrument only select (A). With one exception the selection must coincide with the selection under [F3] in the measuring pattern. Confirm with O.K.

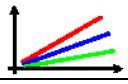


The instrument selected is shown in the dialogue box "measuring instrument". ([F2] cannot be used.)
Provided that the instruments connected provide 1 mV per digit or division on the scale as measuring unit, confirm with "continue".
This is applicable for MINILEVEL "classic" A10, for LEVELMETER 25, A25 with e.g. LEVELTRONIC "classic" A40 but also for MINILEVEL NT11 or LEVELTRONIC NT41 which apart from the digital signal also provide an analogue output.
Attention: The older LEVELTRONIC A40 must **not** be connected directly to a LEVELADAPTER 2000! These must be connected to a LEVELMETER 25 the output of which is linked to the LEVELADAPTER. For this special case the LEVELADAPTER must be selected with one input **LA2000 (A)** and the measuring mode must also be set to **one measuring** instrument. The calculation of the difference is made in the LEVELMETER 25).
For NIVELTRONIC / nivelSWISS or measuring instruments with analogue output from other sources the relation of the voltage to the inclination value must be adjusted. For this function select [F4] in the window shown above.



Enter the voltage per digit or division under F1. For NIVELTRONIC / nivelSWISS the voltage is between 15 mV and 18 mV per division. Newer instruments will be closer to 18 mV, older instruments may be closer to 15 mV. (After entering a selection, e.g. 18 mV per digit, a simple line measurement serves as control measurement. Set the display by the potentiometer to minus 10 divisions and read in a measuring value. Then set the display to plus 10 divisions and read in a value again. If the difference of the two values in the left column of the LEVELSOFT screen is not equivalent to 20 divisions, the deviation in % must be calculated and the value in F1 must be adjusted with the same percentage).
Confirm twice with "continue.

LEVELSOFT PRO is now ready for the measurement.

4.7.19.4	Sensitivity	

When the interface is automatically recognised, also the sensitivity is automatically defined, otherwise it must be set in the respective box.

4.7.19.5	Limit of variation	

Here a limit of variation may be set. When measuring in surrounding conditions not suited for precision measurement (e.g. vibrations) it may be required to gradually increase the limit of variation. Generally it can be said **the higher the limit of variation the higher the measuring uncertainty**, respectively the closure error. The pre-set value is 5 µm/m, respectively 1 Arc sec.

Additional information concerning “limit of variation” see chapter 3.9 remarks concerning the “Limit of Variation”

4.7.19.6	Surveillance of drift	

Due to temperature changes or because of vibrations the zero point of the instrument can drift away. With the activating this menu point such a drift may be checked.

Additional information concerning “Surveillance of drift” see chapter 3.10 remarks concerning the “Surveillance of drift”

4.7.19.7	Limit of drift admissible	

If the surveillance of drift is activated then here the drift tolerance in µm/m, respectively in ArcSec. is displayed.

5 MEASURING OF OBJECTS
5.1 General remarks / Dialogue in status line
5.1.1 ADDRESSING OF THE INSTRUMENTS

During the start-up of the software LEVELSOFT PRO the interface connected to the serial port is detected. Therefore the measuring configuration, e.g.

- **BlueMETER**
- **LEVELMETER 2000**
- **LEVELMETER „light“**
- **LEVELADAPTERBOX 2000**

must be connected and operational.

5.1.2 Firmware-Update
5.1.2 a Version of the BlueMETER / Firmware-Update BlueMETER

Important:
For the new version of the software LEVELSOFT PRO WyBus a BlueMETER with the latest firmware must be used. An instruction sheet for the update and the actual version can be found in the Internet www.wylerag.com in the area Products / Software / Software or Software-updates for LEVELSOFT PRO.

In case you face any problems with the upload / update please contact immediately your local WYLER partner or WYLER SWITZERLAND directly

- E-MAIL: wylerag@wylerag.com
- Phone: 0041 52 233 66 66
- Fax: 0041 52 233 20 53

Checking the firmware-version of the BlueMETER:

- Switch the **BlueMETER** on using the <ON/MODE> key
- Switch now the **BlueMETER** off again using the <ON/MODE> key and hold the <ON/MODE> key down for approx. 10 seconds
- In the display the following will appear
  - The date of the actual SW-version / e.g. 20.09.2008
  - the version number / e.g. F0186 T3W B3.7.0

Display BlueMETER

5.1.2 b Version of the LEVELMETER 2000 / SW-Update LEVELMETER 2000

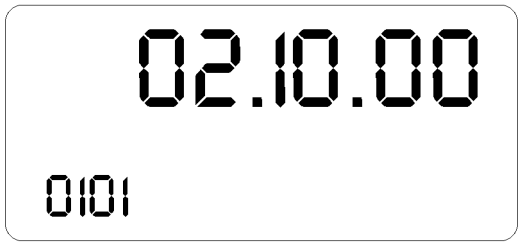
Important:
For the new version of the software LEVELSOFT PRO WyBus a LEVELMETER 2000 with the latest firmware must be used.

An instruction sheet for the update and the actual version can be found in the Internet www.wylerag.com in the area Products / Software / Software or Software-updates for LEVELSOFT PRO.

Checking the SW-version of the LEVELMETER 2000:

- Switch the **LEVELMETER 2000** on using the <ON/MODE> key
- Switch now the **LEVELMETER 2000** off again using the <ON/MODE> key and hold the <ON/MODE> key down for approx. 10 seconds
- In the display the following will appear
  - The date of the actual SW-version / e.g. 002.10.2000
  - the version number / e.g. 0101

Display LEVELMETER 2000



Update of the Software for LEVELMETER 2000
The RS 232 cable used for measuring with LEVELSOFT PRO cannot be used for an up-date. One of the following two cables must be available: WYLER P/N 065-025-978-04A or P/N 065-025-978-PC+.

- Load the **Update-File "lm2000.exe"** from the WYLER Website www.wylerag.com or from the WYLER CD "ALL-IN-ONE" to a temporary directory on your PC
- With a double-click you can now unpack (un-zip) the file
- You can now find the relevant instructions fort he upload in the following files:
  - *liesmich.txt" in German language
  - "lisezmoi.txt" in French language
  - "readme.txt" in English language
- In case you face any problems with the upload / update please contact immediately your local WYLER partner or WYLER SWITZERLAND directly
  - E-MAIL: wylerag@wylerag.com
  - Phone: 0041 52 233 66 66
  - Fax: 0041 52 233 20 53

Configuration of the measuring set

Two basic possibilities exist:

Measuring instruments connected to the Interface by cables

Using the classic configuration the instruments (**MINILEVEL NT** und **LEVELTRONIC NT**) are connected via cables to the interface (LEVELMETER 2000 or Levelmeter C25 (analogue Version))

Instruments of the NT series can also directly be connected to a LEVELADAPTER 2000.

Measuring instruments connected to the Interface by wireless data transmission

In the configuration of NT instruments with "wireless transmission" the measuring data will be transmitted by radio signals to the external display unit (only possible with LEVELMETER 2000 with radio).

BlueSYSTEM is optimized for wireless transmission of the data. Nevertheless the instruments can also be ordered without the radio modules for data transmission by cables. Those instruments can be upgraded with radio transmission modules at a later stage.

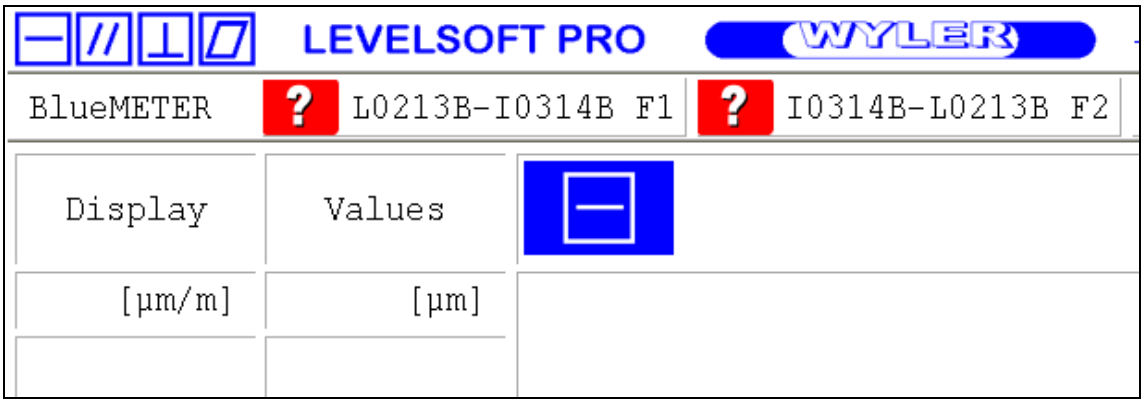
In the example "measuring a line" the difference between the two options is displayed.

5.1.3 Measuring instruments connected to the Interface by cables or wireless data transmission

Start the software LEVELSOFT PRO. Define the measuring task. “File/Measuring pattern new/change” as follows:

- Object: LINE
- Way of measuring: Differential measurement (two instruments)
- Instrument: BlueMETER / Provided that the instrument has been used for the last measurement performed, has been connected to the same port and is ready it will automatically be connected
- Sensitivity: 1 µm/m (automatically recognised)
- Limit of variation: 5 µm/m
- Surveillance of drift: NO

<Start measurement> / or key [F11]



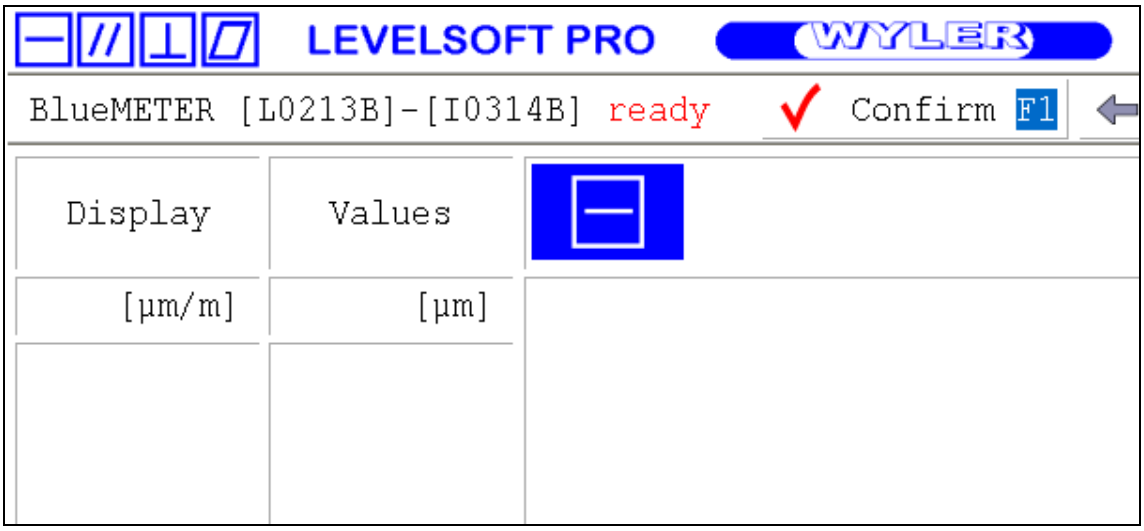
In the configuration with reference measurement the two possible configurations of measuring and reference instrument appear.

It is recognised that there is a configuration with two measuring instruments with wireless data transmission. The user is now to decide which one of the two instruments will be used as the "measuring instrument" respectively as the "reference instrument". The configuration connected is recognised. Click now on the configuration required or select using the function keys [F1] or [F2].

L0213B – I0314B F1

I0314B – L0213B F2

After the selection the measuring instruments will be initialised accordingly.

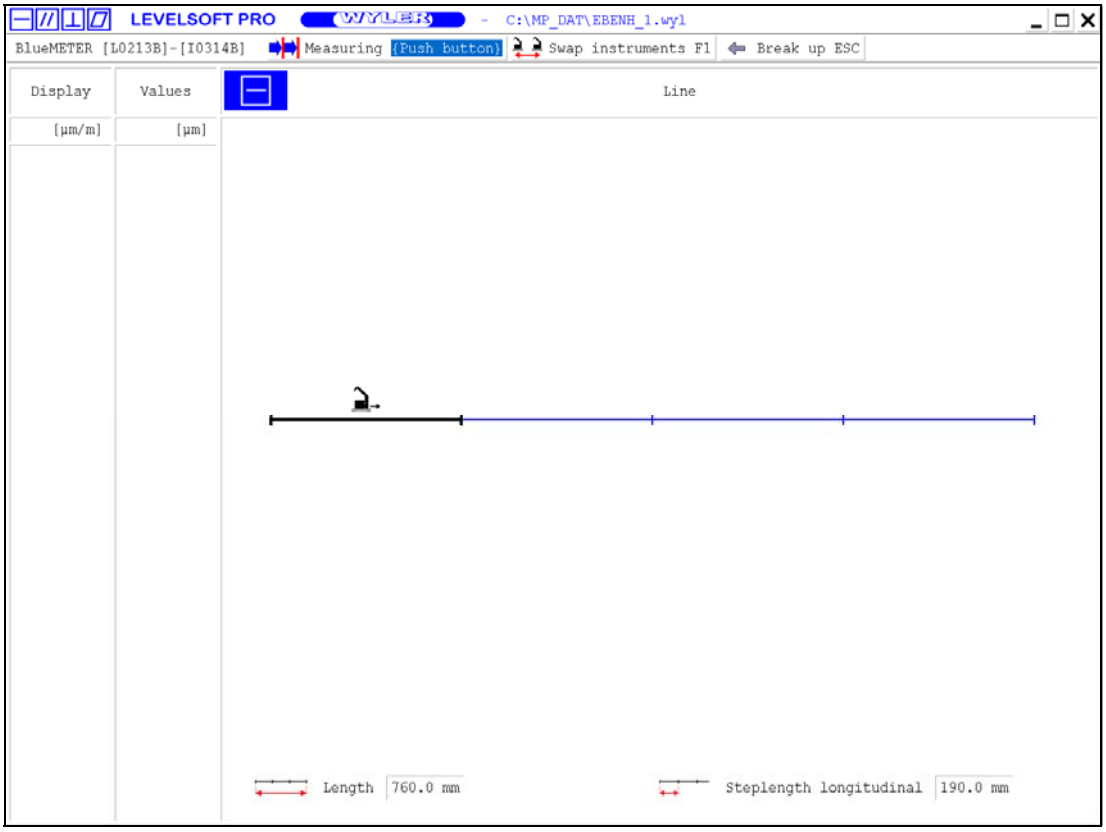


The configuration connected will be recognised. The information "ready" is blinking.

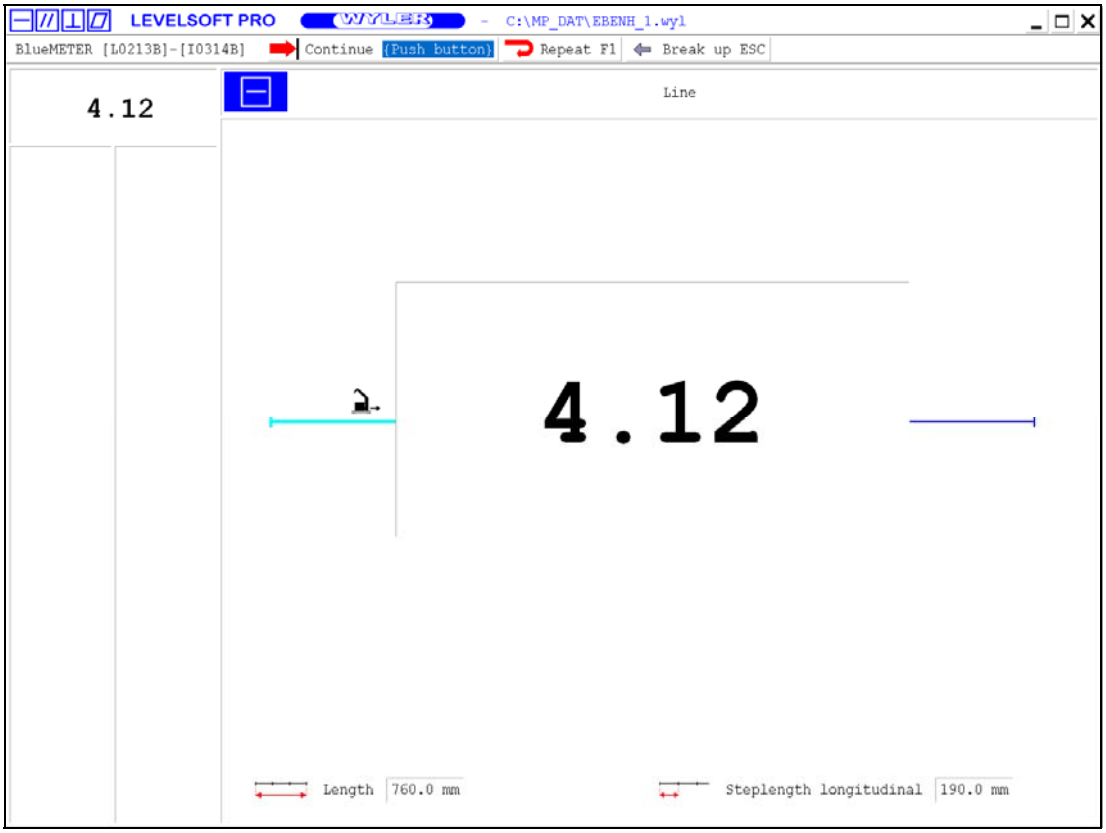
For safety reasons you are asked to confirm the selection again with <CONFIRM> / [F1].

If the message "no measuring instruments" or *not enough instruments" appears instead of the serial numbers, the instruments are not correctly connected / configured. In this case check whether all the instruments are ready and newly connect them as described in chapter 5.1.4.

After confirmation of the configuration you can start with the actual measurement



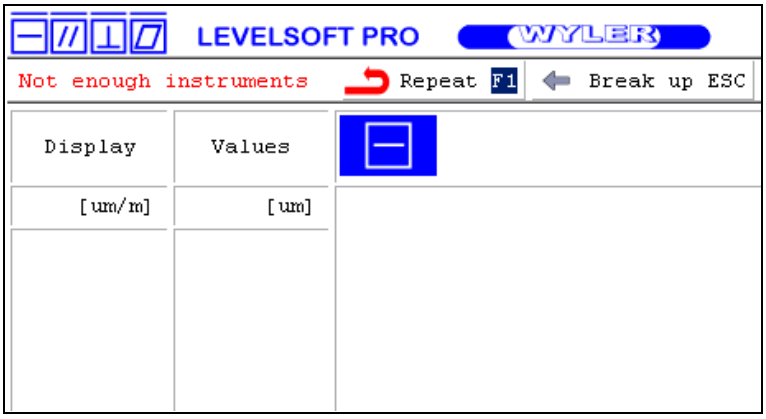
It is important to know that all settings, such as measurement with one instrument or reference measurement must by carried out through the software LEVELSOFT PRO. **The settings on the BlueMETER or on the LEVELMETER 2000 are overruled.** During the measurement the keys on the BlueMETER are blocked.



After successful collecting of the measurement data the value will be displayed on the screen for checking in large letters. When continuing with the confirmation of the value the displayed figures disappear and the next position for the measuring instrument will be shown.

5.1.4 POSSIBLE ERROR MESSAGES

You have configured the way of measurement as "reference measurement" (instrument [A-B]) and the instruments have been configured accordingly.



At the start of the measurement the error message

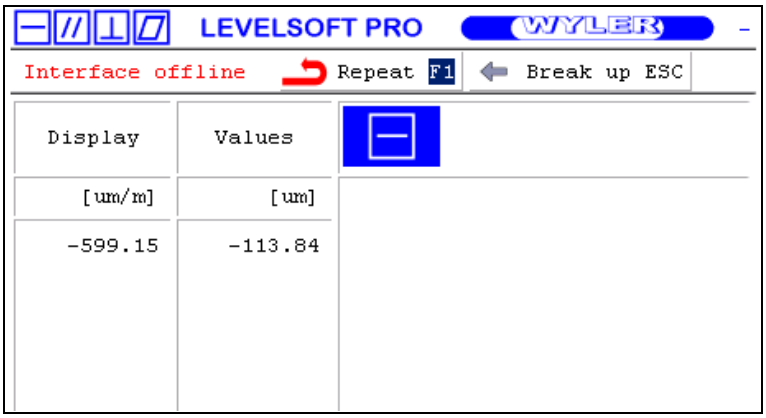
"NOT ENOUGH INSTRUMENTS"

appears together this the request

"REPEAT"

Check the instrument settings and the cable respectively the wireless connection.
With the key <repeat> a re-initialisation of the configuration will be started.

If the data line between the interface (BlueMETER, LEVELMETER 2000, LEVELMETER LIGHT, LEVELADAPTER 2000) and the PC is interrupted (cable disconnected, cable defective, etc.) in the status line the information below.



Special case LEVELMETER LIGHT / BlueMETER LIGHT:
If the software detects a configuration not compatible with the settings, (e.g. setting for a single instrument, display @LL00s but two instruments connected) the software LEVELSOFT PRO will display with the first measurement "Instruments offline".
With a setting for two instruments, Display @LL00d, but only one instrument connected LEVELSOFT PRO will display "no instrument".
(Depending on the circumstances, the LEVELMETER LIGHT may require a new configuration after one of these messages ⇨ see chapter 4.7.19.3 - case III)

INTERFACE OFFLINE or INSTRUMENTS OFFLINE

will appear with the request

"REPEAT"

After repair the measuring instruments will be re-initialised. The information that the instruments are ready again will appear. This must be confirmed with the <CONFIRM> button. Now the measurement can be continued.

5.1.5 SWAPPING THE INSTRUMENTS DURING THE MEASURING PROCEDURE

Measuring Instrument >>> Reference Instrument
Reference Instrument >>> Measuring Instrument

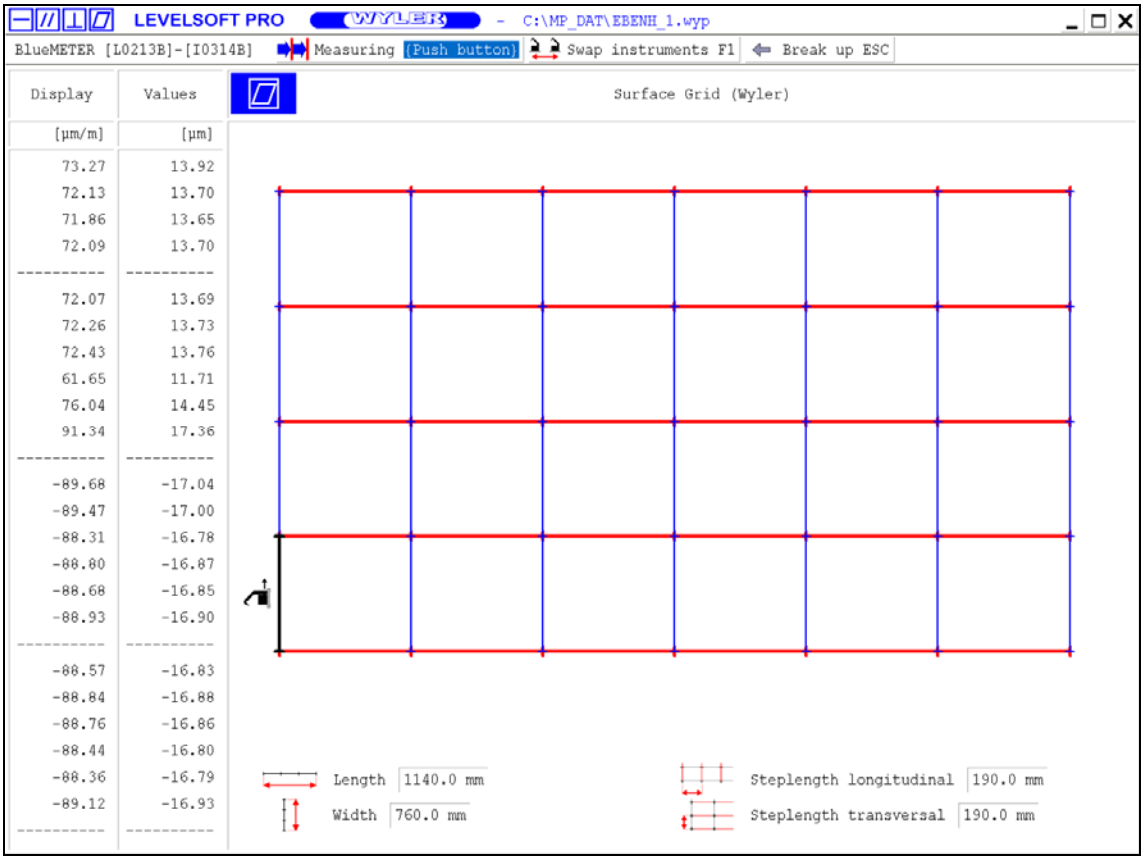
During a measuring procedure it may be required to exchange the instruments so that the measuring instrument will become the reference instrument and vice versa. This may be useful when the instruments are equipped with different sizes of bases and the flatness of a surface must be measured with different step length longitudinal and transversal. In such a case the instruments can be exchanged when the longitudinal lines are measured.

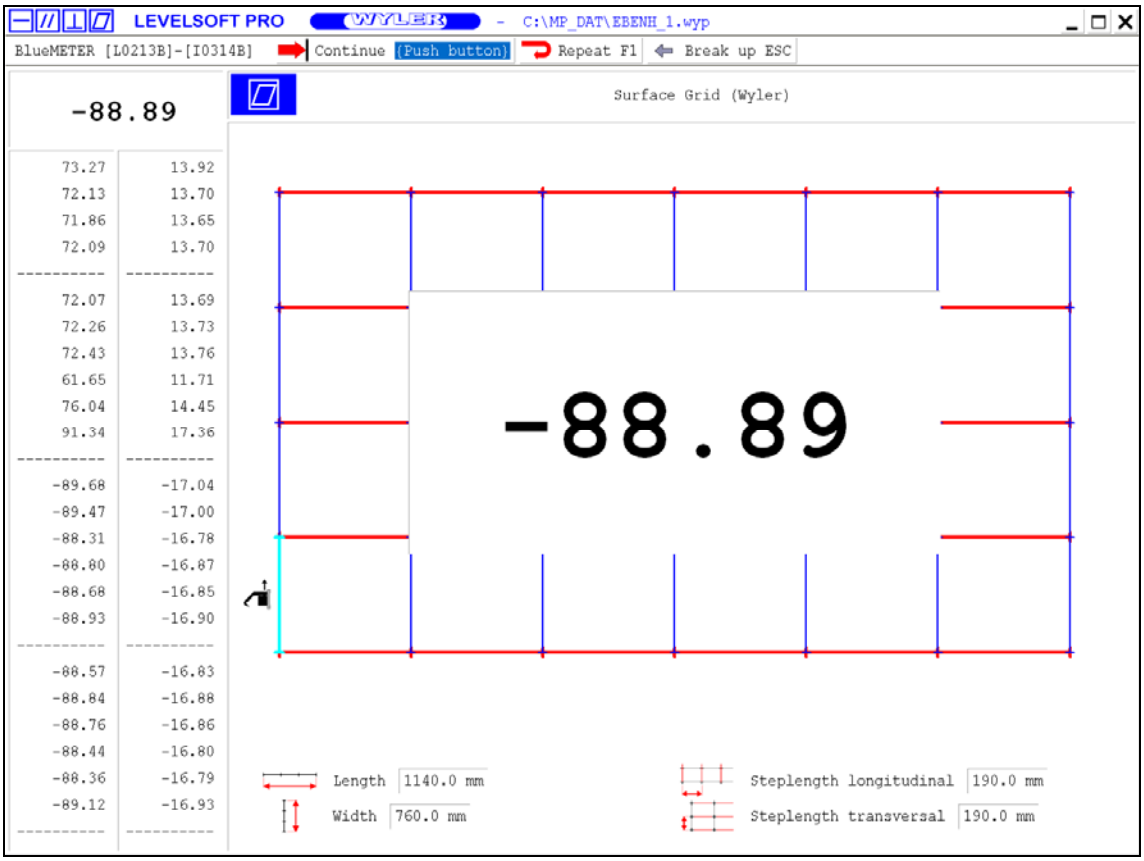
IMPORTANT:
The exchange of measuring instruments during a measurement may only be performed when the measuring direction will be changed, e.g. from longitudinal to transversal lines in a flatness measurement .If the instruments are exchanged, e.g. during the measurement of parallel lines, the **measuring result** will be **useless**.

Exchange of Measuring Instruments
In configurations where the **measuring instruments** are connected to the interface **through cables or via wireless data transmission**

After the last measurement of longitudinal lines of a granite master plate the option to exchange the measuring instruments will appear in the status line. Exchange now the two instruments by activating the <EXCHANGE INSTRUMENTS> button or the function key [F1]. The measuring instruments need not be re-connected through cables, however, the placing of the instruments must be considered.

If a LEVELADAPTE 2000 is used, the instruments may / must be re-plugged at the LEVELADAPTER 2000. The function key F1 is not available.
If a LEVELMETER LIGHT or a BlueMETER LIGHT is used, the instruments may / must be re-plugged at the LEVELMETER LIGHT or BlueMETER LIGHT. The function key F1 is not available.





After such an exchange of the instruments after termination of the measurement of longitudinal lines the software will recognise that the initial configuration has been changed. The new configuration will be displayed in the status line.

Configuration of measuring instruments before the exchange: **L0213B – I0314B**

Configuration of measuring instruments after the exchange: **I0314B – L0213B**

The measurement can now be continued.

NOT APPLICABLE when using a LEVELMETER LIGHT, BlueMETER LIGHT or LEVELADAPTER 2000!

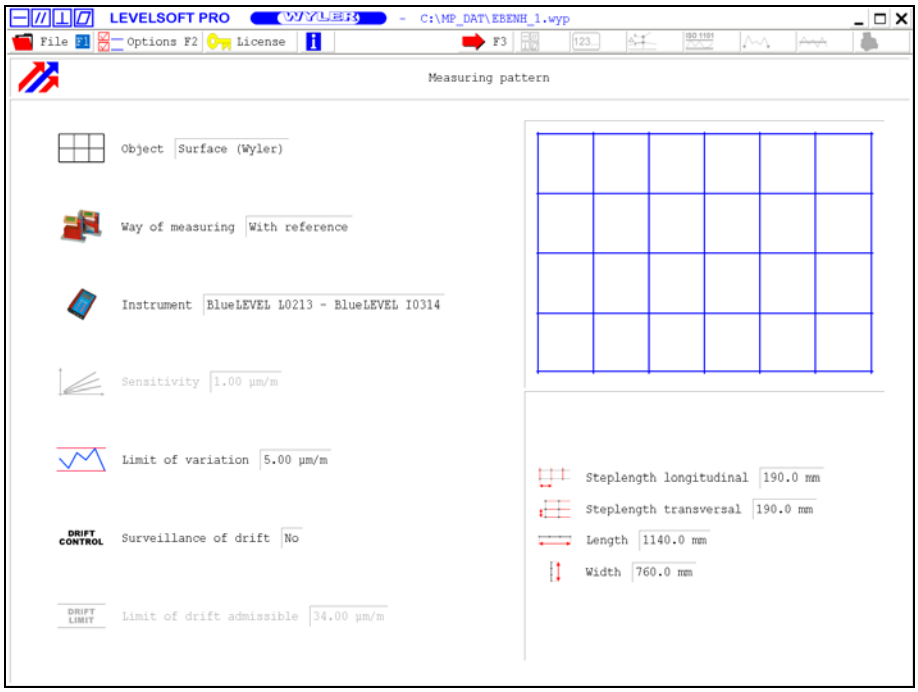
5.2 MEASUREMENT OF LINES

The measuring procedure and the description of the various parameters are shown with a simple example of measuring a line.

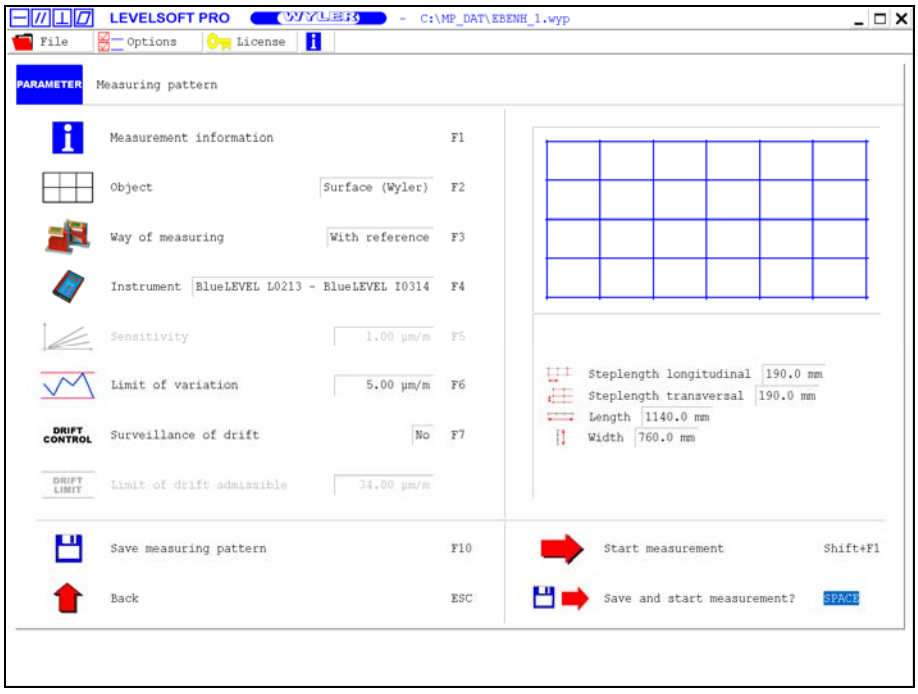
Example:
Measurement of a granite straight edge with a total length of 1050 mm, with two instruments

- Two instruments connected to a PC via BlueMETER
- Base length of instruments: 150mm
- Step length: 125mm

After starting the software LEVELSOFT PRO the last used **measuring pattern** is displayed.



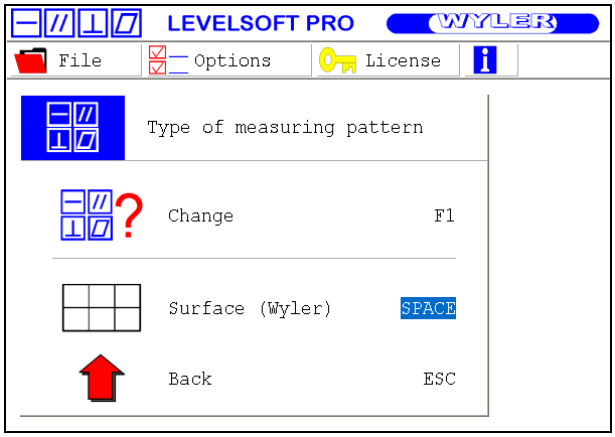
Open the menu point “File / Measuring pattern new / Change”.



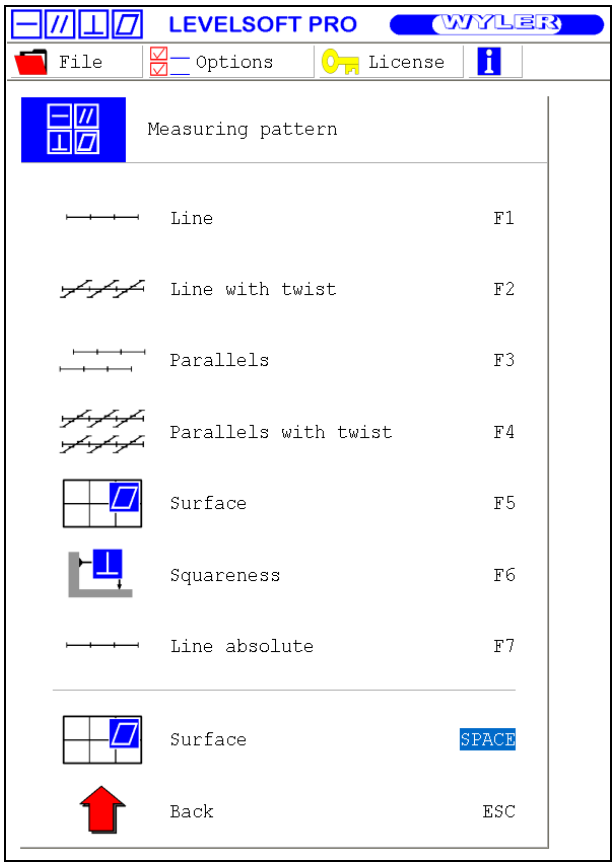
The different positions can now be adjusted to the requirements of the measuring task:

- Object
- Way of measuring
- Instrument (BlueMETER resp. EVELMETER 2000 are automatically recognised and displayed)
- Sensitivity (when using a BlueMETER or a LEVELMETER 2000 the sensitivity of the measuring instrument is automatically recognised and will not be displayed on the monitor)
- Limit of variation
- Surveillance of drift
- Limit of drift admissible (only when surveillance of drift is activated)

As a first step the actual measuring object must be changed clicking to "Object" or key [F1].



The last used measuring object (Surface WYLER) is displayed. For changing the measuring object we click to "Object" or key [F1].



The following dialogue box is seen with the listing of the possibilities of the objects:

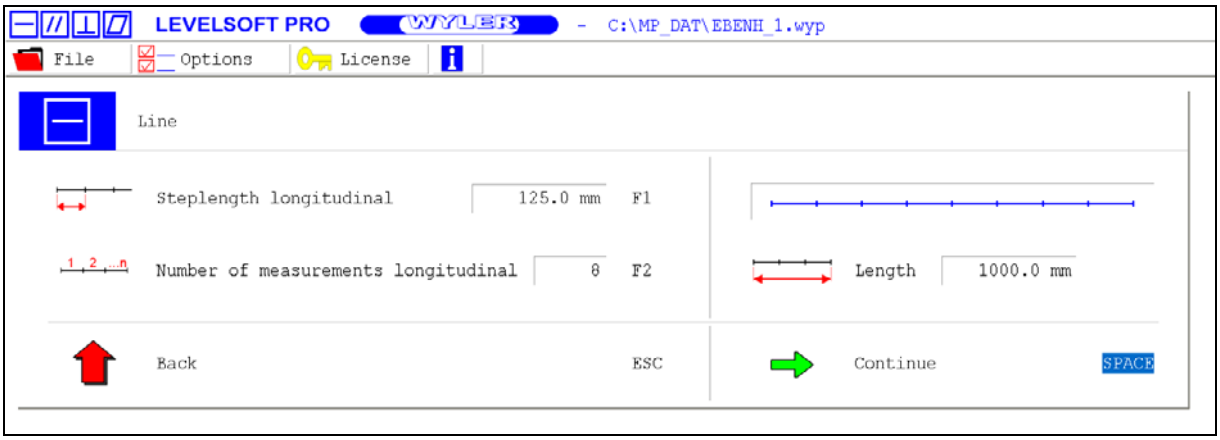
- **LINE**
  Measurement of lines
- **LINE WITH TWIST**
  Measurement of lines with twist
- **PARALLELS**
  Measurement of up to 3 parallels
- **PARALLELS WITH TWIST**
  Measurement of up to 3 parallels with twist
- **SURFACE (Flatness)**
  Measurement of surfaces, respectively flatness
- **SQUARENESS** (Measurement of right angle)
  Measurement of 90 deg. Angles
- **LINE ABSOLUTE**
  Measurement of a line with absolute values

In our example we chose <LINE> / [F1]

Enter now the parameters

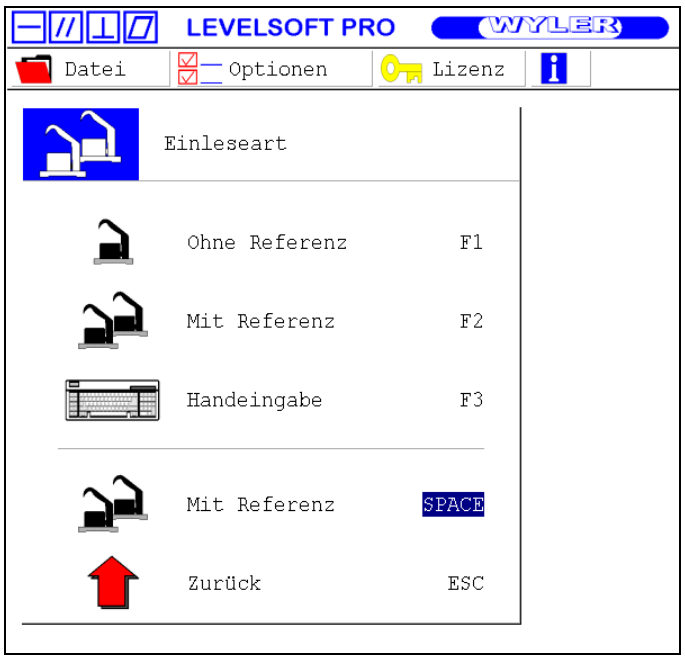
- Step length: 125mm
- Number of measurements 5

The data is displayed in the monitor (top right) and can be accepted with <Continue> / [SPACE]



Now return to the entering mask for the measuring pattern. The change of the measuring object is now visible. In the right hand section of the screen the pattern entered can be checked graphically and numerically.

As a next step the “Way of measuring” must be changed. The present setting is "single instrument". The task is to use two instruments in differential mode. Use the mouse to click on "way of measuring) or the key [F3].



As the present way of measuring "measurement with one instrument" has been selected. In order to change this to "reference measurement" / instruments [A - B] we click with the mouse on <with reference> or action the function key [F2].

You return now to the entering mask for the measuring pattern. The change of the way of measuring to "instrument [A - B]" is now visible.

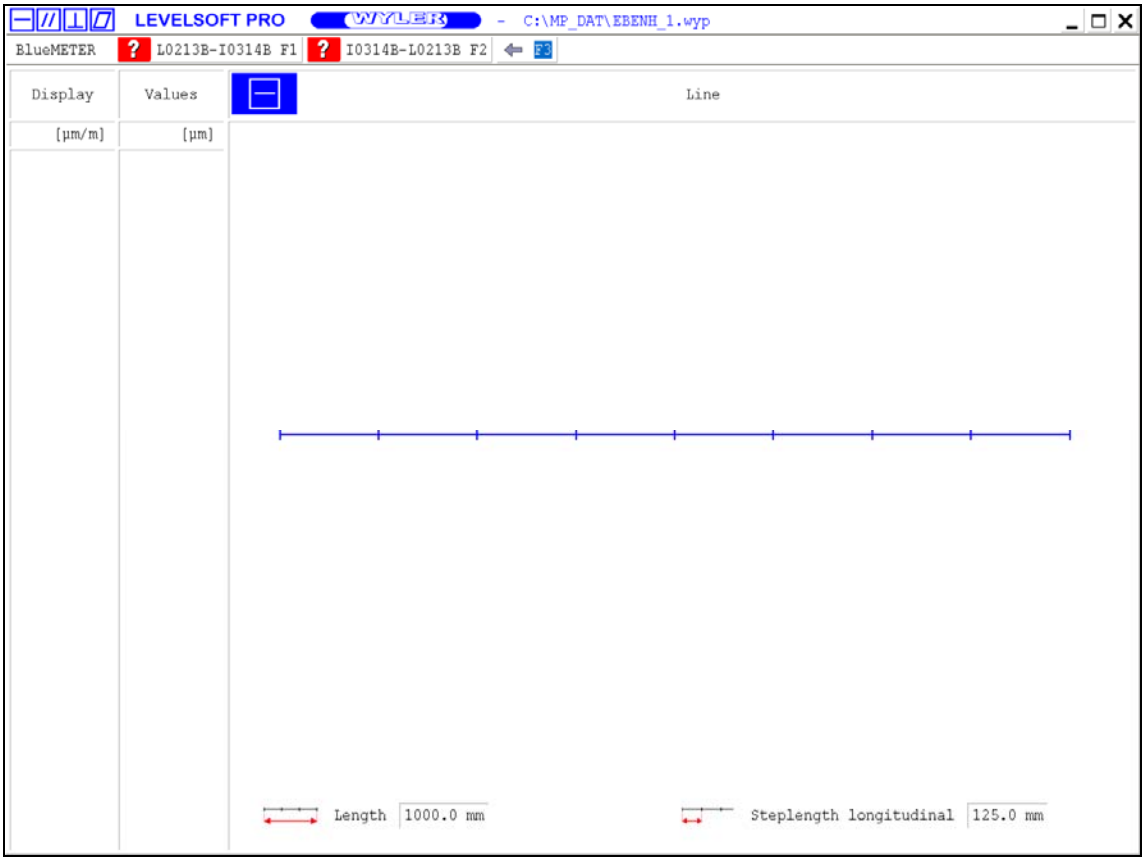
The following parameters can be set now:

- Limit of variation
  and
- Surveillance of drift c/w Limit of drift admissible

If in the window next to [F4] only one instrument is visible or the picture does not show the instrument in use, the instruments must newly be connected.

After defining this new configuration, respectively the new measuring pattern the following procedures are now possible:

- With <SAVE MEASURING PATTERN> [F10] you can save the configuration for later use as a measuring pattern without starting the actual measurement.
  Such a procedure makes sense when first a number of different patterns will be defined for later use.
- With <START MEASUREMENT> [F11] you start a measurement without saving as measuring pattern
- With <SAVE AND START MEASUREMENT> / [SPACE] you will be asked to save the configuration as a measuring pattern before starting the measurement



Now you must assign the measuring and reference instrument.

Configuration of measuring instruments before the exchange: **L0213B – I0314B**

or

Configuration of measuring instruments after the exchange: **I0314B – L0213B**

After that you can start the measurement.

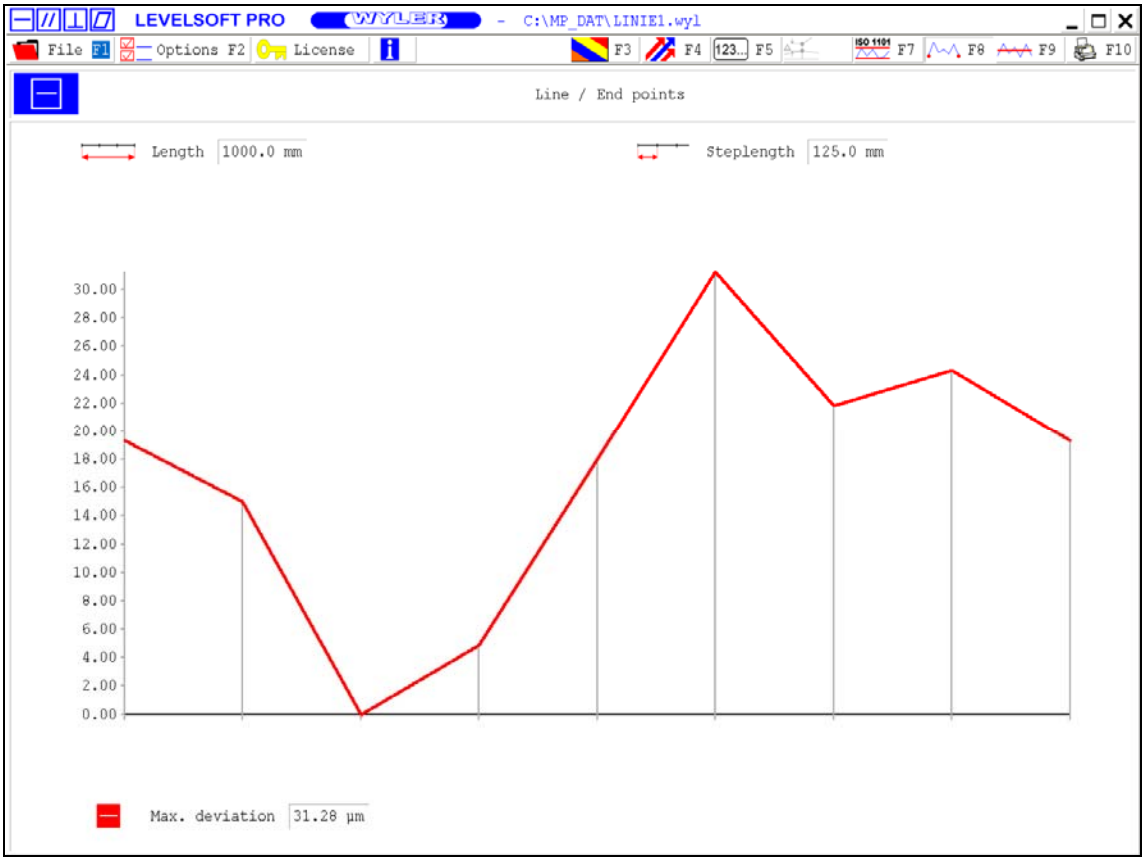
During the measurement the following information is visible on the screen:

- Display value: Corresponds to the measuring value shown on the instrument respectively in case of a differential measurement it corresponds to the difference between the two instruments (value [A] minus value [B]
- Values: Corresponds to the display value reduced to the step length
- Graph: Shows the position where the measuring instrument must be placed
- Length: Total length of the line to be measured
- Step length: Step length for each individual measurement

Repeat measurements:

- After reading of the actual measuring value the measurement can be repeated by <REPEAT> / [F1]
- After confirmation of the measuring value last entered you can repeat the last measurement respectively the last measurements of the actually measured line using the button <BACK> / [F2]

After the last measurement has been taken automatically the following graph of the measured line is displayed:



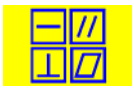
The following information is seen:

- Graph: Shows the straightness of the measured line in graphical form
- LINE / End points: The display shows the alignment according to the "**End points"** method
- Maximum error: Error of the straightness of the line
- Length: Total length of the line measured
- Step length: The step length of each individual measurement

The following additional options are available:

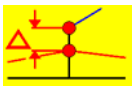
Display in colour [F3]
Using the key [F3] several times the colour display changes to different options until the graphical display appears again

Switch to "Measuring pattern" [F4]

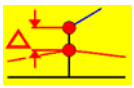


Switch to graphical display [F4]

Display of the measured values at the points of measurement [F5]

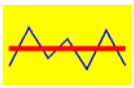


Use Philips Correction for eliminating the closure errors [F6],
only possible on closed objects such as e.g. Surface WYLER



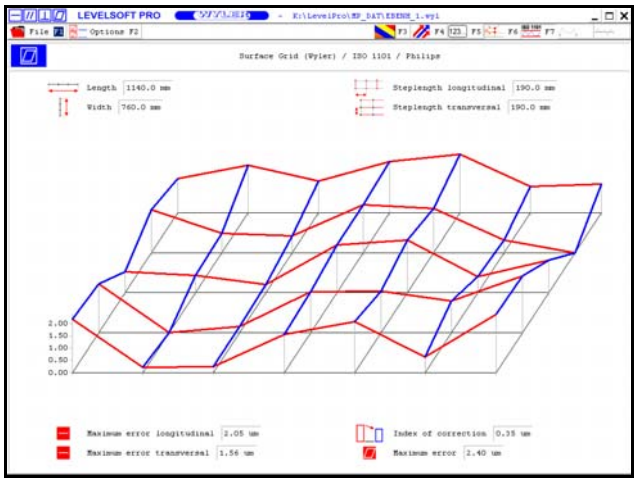
Alignment method ISO1101 [F7]

Alignment method End points [F8]

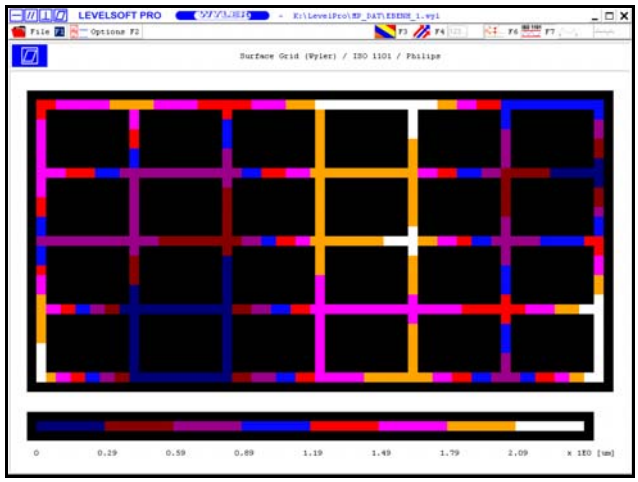


Alignment method Linear regression [F9]

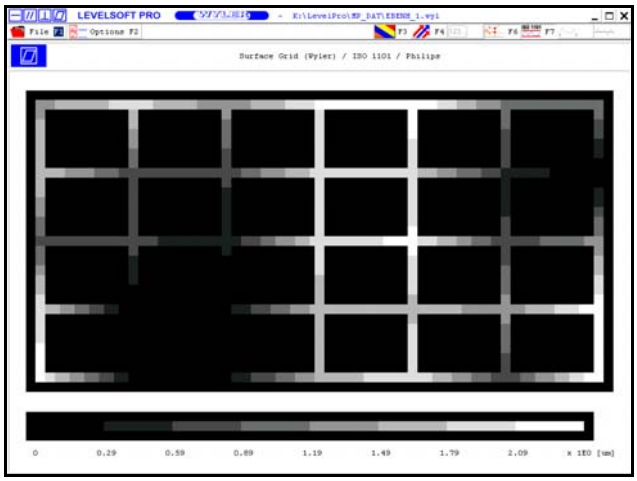
Display in colour [F3] (Example: flatness)



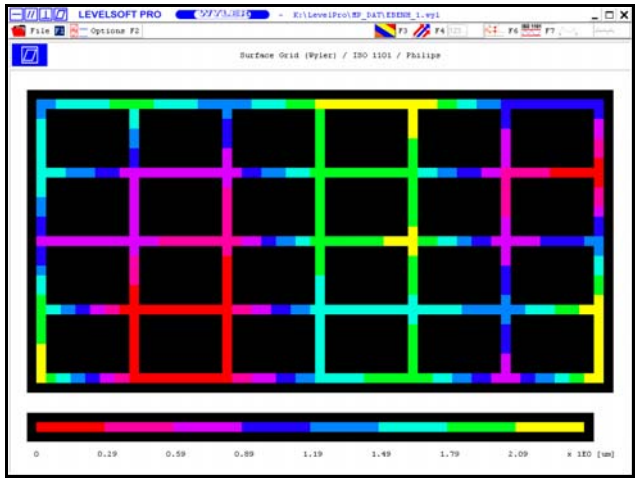
Display in line form



Display in colour (Scale 1)

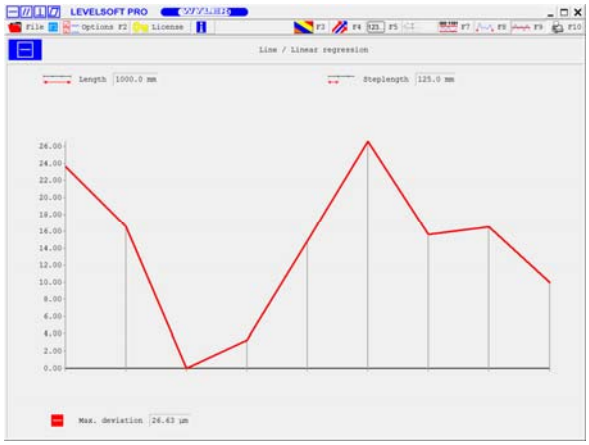


Display grey

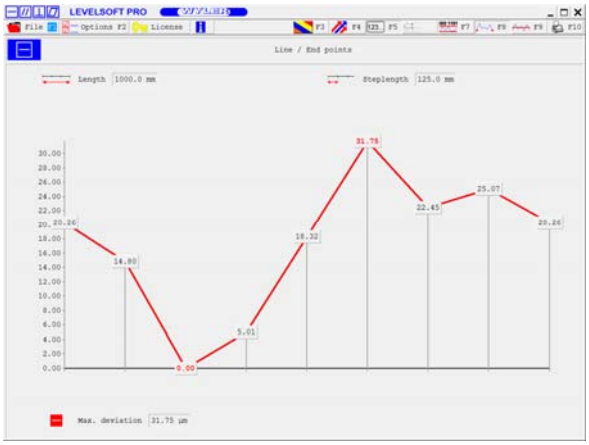


Display in colour (Scale 2)

Display of the measured values at the points of measurement [F5]



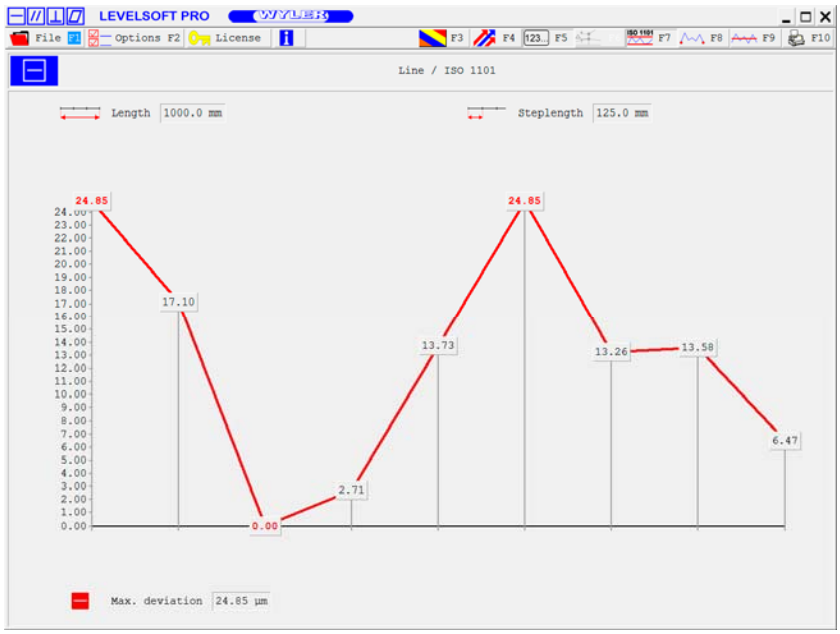
Display without numerical values



Display with numerical values

- **1 click on <123> / [F5]:** All values will be displayed numerically
- **2 clicks on <123> / [F5]:** The number of numerical values displayed will be reduced continuously
- **3 clicks on <123> / [F5]:** Only the **highest and the lowest value** will be displayed

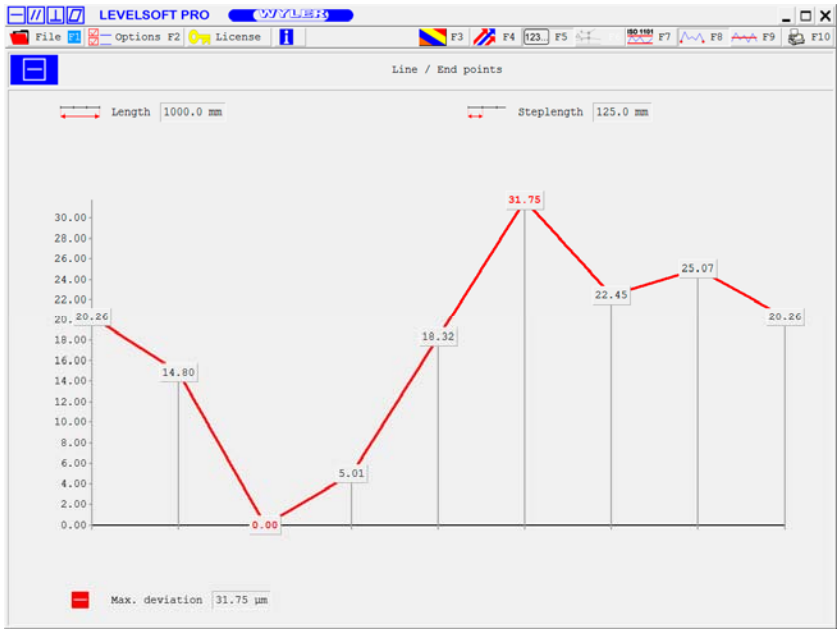
Alignment methods ISO1101 / End points/ Linear regression



Use alignment method ISO1101 [F7]

Maximum error for straightness in our example is: 24.85 µm

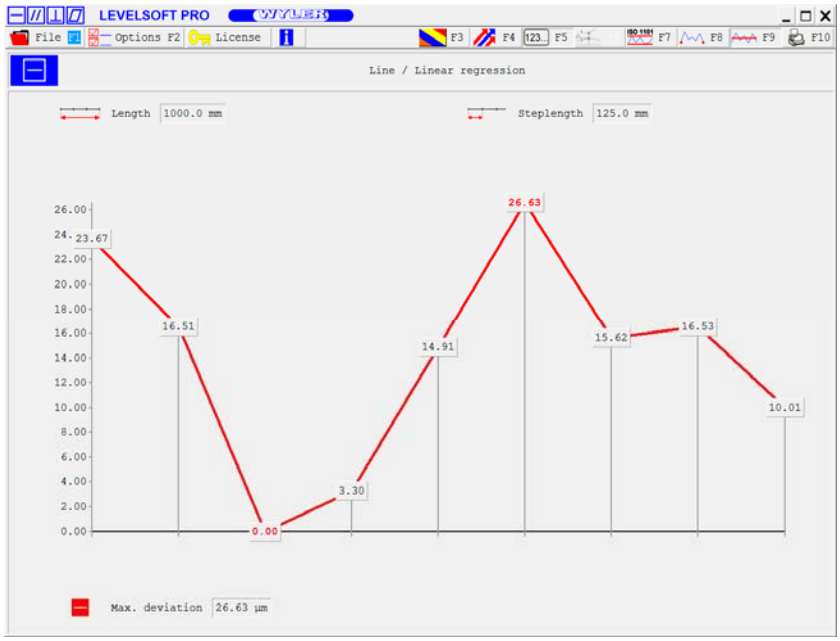
The scale on the left hand side helps for better judgment



Use alignment method End points [F8]

Maximum error for straightness in our example is: 31.75 µm

The scale on the left hand side helps for better judgment



Use alignment method Linear regression [F9]

Maximum error for straightness in our example is: 26.63 µm

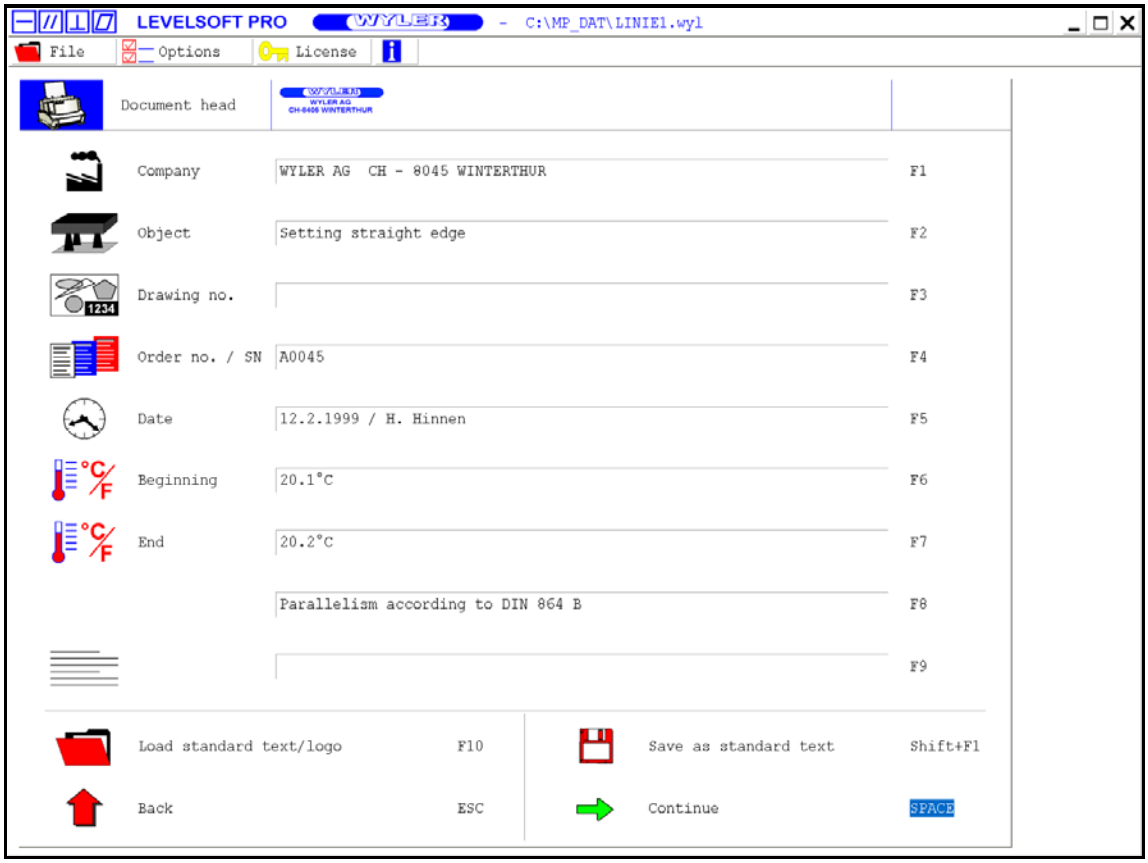
The scale on the left hand side helps for better judgment

Printing the measuring values

Printing the results of a measurement. After a measurement the results may be printed. Using the menu point “File / Print measurement” the following display is seen for entering the information to be printed later in the header sheet.
Using the menu point <Load standard text> / [F1] it is possible to use a preset text module which can be accepted or altered.

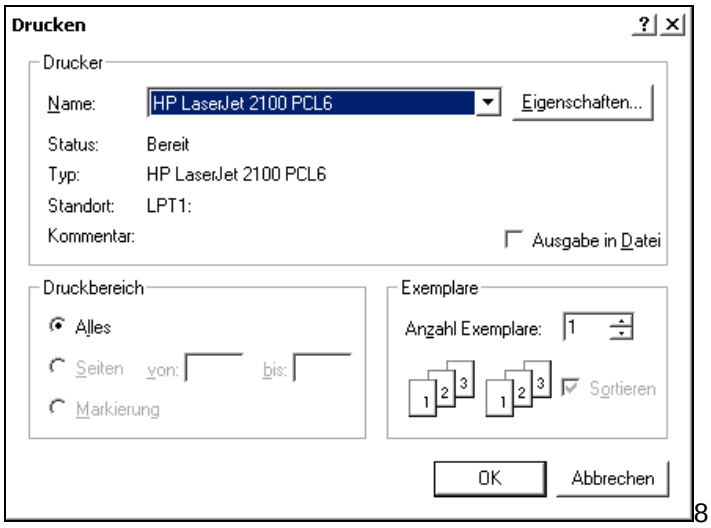
Using the menu point "Options / Set-up printing standard" it is possible to adjust the print out according to the individual requirements (see below)

- Printing from top
- Printing from bottom
- Printing from left
- Printing from right
- Print numerical measuring values YES / NO
- Print profile in landscape (Paper format A4) YES / NO



When <Save as standard text> / [F11] is activated the newly entered text will be taken as future standard text

Apply <Continue> / [SPACE] for selecting the printer and click OK for starting the print procedure.



8

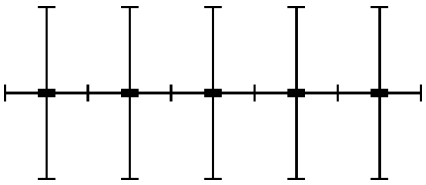
5.3 MEASUREMENT OF LINES WITH TWIST

The complete procedure is described on an example of a simple measurement of a line with twist.
Most of the actions are identical to the measurement of a line and therefore not specifically repeated.

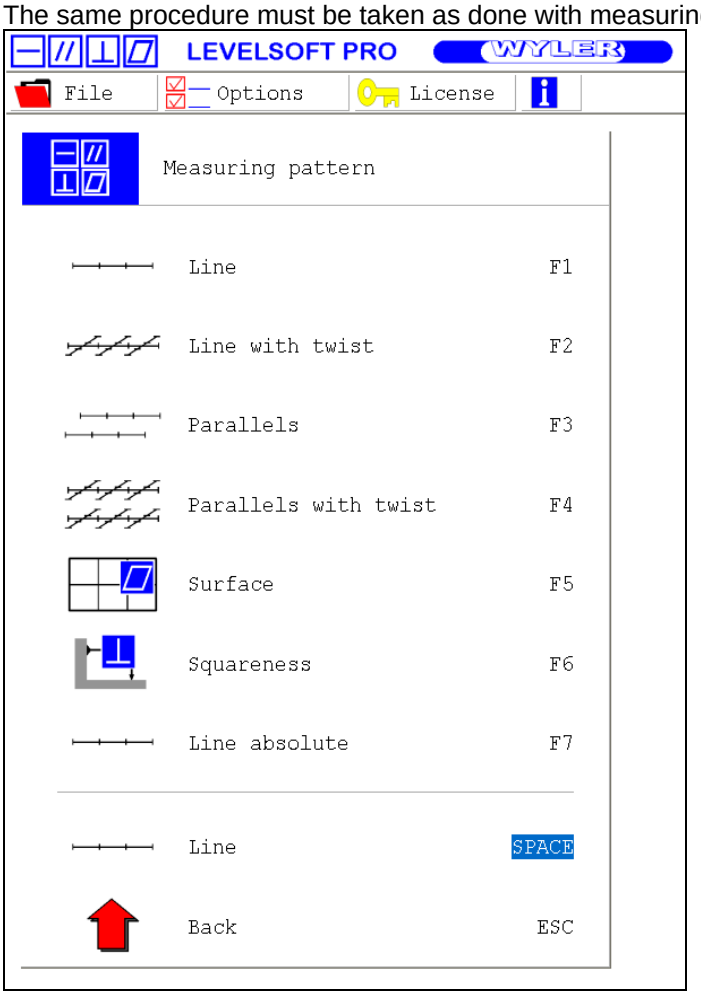
Example:
Measurement of a granite straight edge with a total length of 650 mm, with two instruments

- Two instruments connected to a PC via Levelmeter 2000
- Number of measurements: 5
- Base length instruments: 150mm
- Step length longitudinal: 120mm
- Step length transversal: 120mm (Twist)

Object to be measured: "LINE WITH TWIST"



The same procedure must be taken as done with measuring a line



The following dialogue box is seen with the listing of the possibilities of the objects:

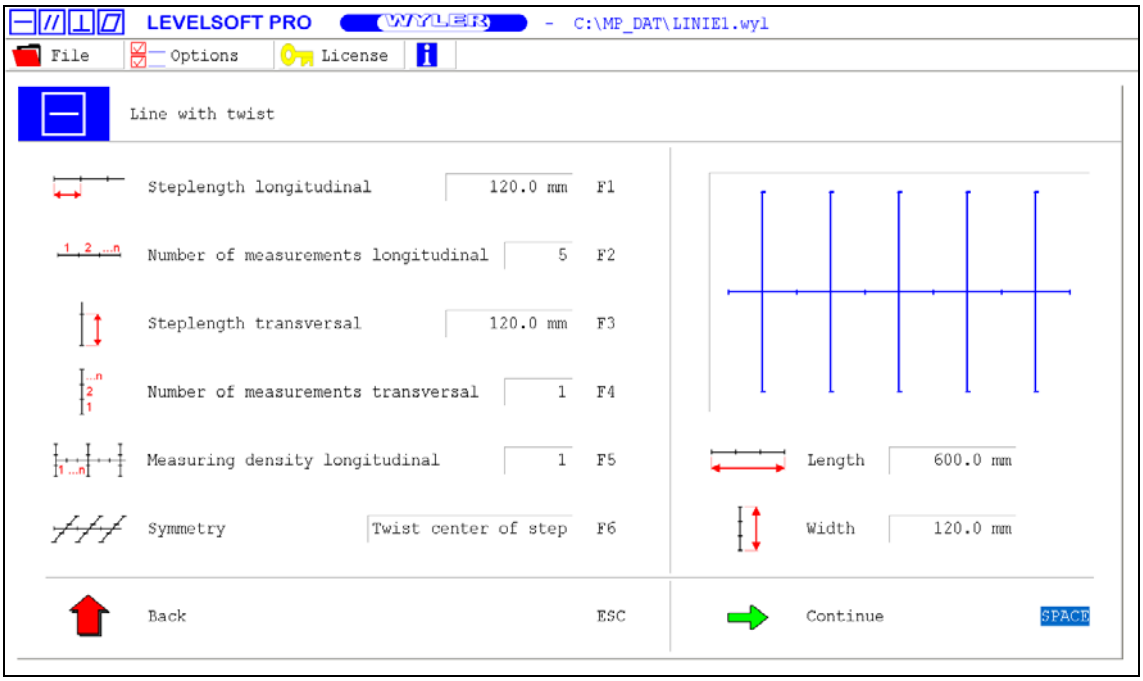
- **LINE**
  Measurement of lines
- **LINE WITH TWIST**
  Measurement of lines with twist,
- **PARALLELS**
  Measurement of up to 3 parallels
- **PARALLELS WITH TWIST**
  Measurement of up to 3 parallels with twist
- **SURFACE (Flatness)**
  Measurement of surfaces, respectively flatness
- **SQUARENESS** (Measurement of right angle) Measurement of 90 deg. Angles
- **LINE ABSOLUTE**
  Measurement of a line with absolute values

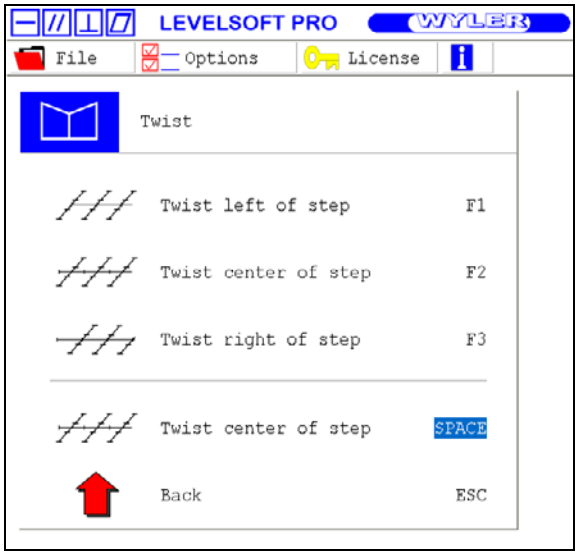
In our example chose <Line with twist> / [F2]. The entering mask for the parameters appears

The following parameters must be entered:

- Step length longitudinal: 125mm
- Number of measurements longitudinal: 5
- Step length transversal: 120mm
- Number of measurements transversal: 1
- Measuring density longitudinal : 1
- Symmetry: "Twist centre of step"

The data is displayed in the monitor (top right) and can be accepted with <Continue> / [SPACE]





Choice **SYMMETRIE**:

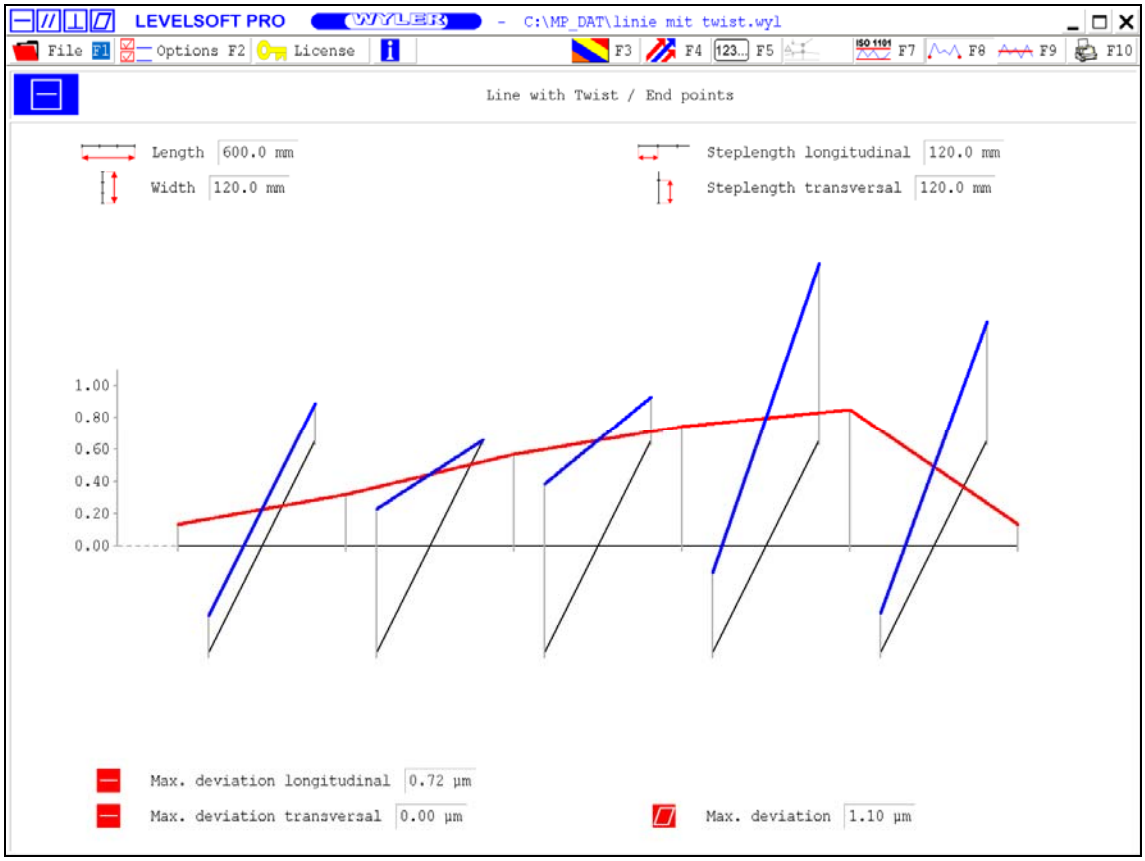
- Twist left of step [F1]
- Twist centre of step [F2]
- Twist right of step [F3]

The other steps are identical to measuring a line:

- Way of measuring
- Limit of variation
- Surveillance of drift
- Start measurement, with/without saving the measuring pattern

is identical to measuring a line

After the last measurement has been taken automatically the following graph of the measured line is displayed:



The following information is seen:

- Graph: Shows the straightness of the measured line with twist in graphical form
- Line with twist / Endpoints: The display shows the alignment according to the "**End points"** method
- Maximum error longitudinal: Maximum error of the line longitudinal
- Maximum error transversal: Maximum error of the transversal measurement, provided that this consists of more than one step
- Maximum error: Maximum flatness error of the complete measuring object
- Length: Total length of object
- Width: Total width of object
- Step length longitudinal: Step length longitudinal
- Step length transversal: Step length transversal

The following steps

- Display in colour [F3]
- Alignment methods
- Switch between graphical display and measuring pattern [F4]
- Display measured values [F5]
- Printing

are identical to the measurement of a "LINE".

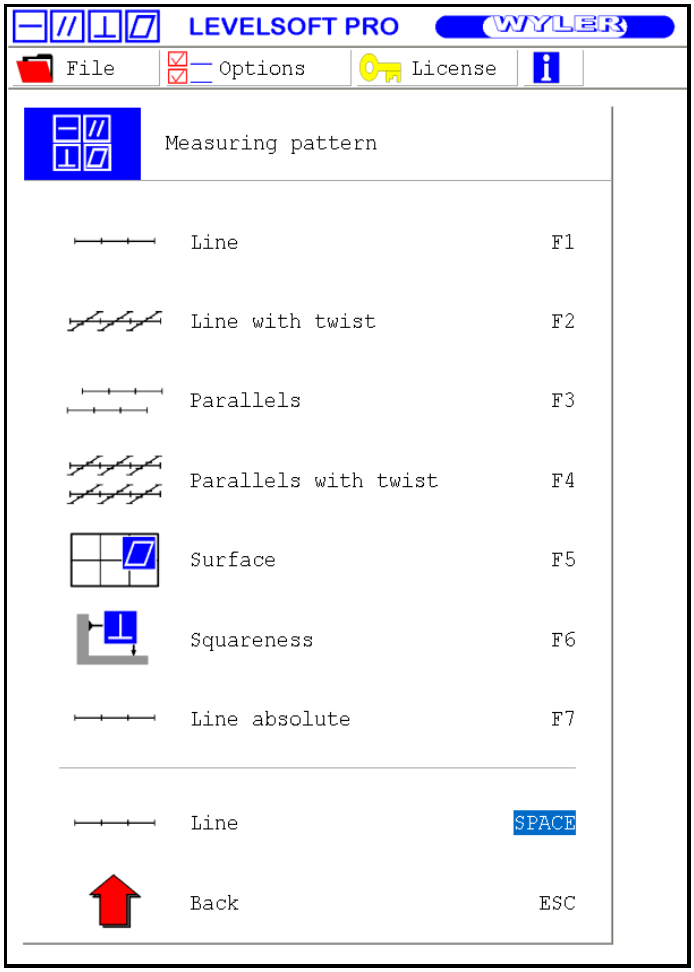
5.4 MEASUREMENT OF PARALLELS

Up to 3 parallel lines can be measured.
The measuring procedure and the description of the various parameters are shown with a simple example of measuring parallel lines. Most of the steps are identical to measuring a line

Example:
Measurement of three parallel lines with two instruments

- Two instruments connected to a PC via Levelmeter 2000
- Line 1: 3 Steps at 125mm
- Line 2: 5 Steps at 140mm
- Line 3: 4 Steps at 130mm
- Base length instruments: 150mm

Up to the selection of the object we follow the steps described in "Measuring a Line"



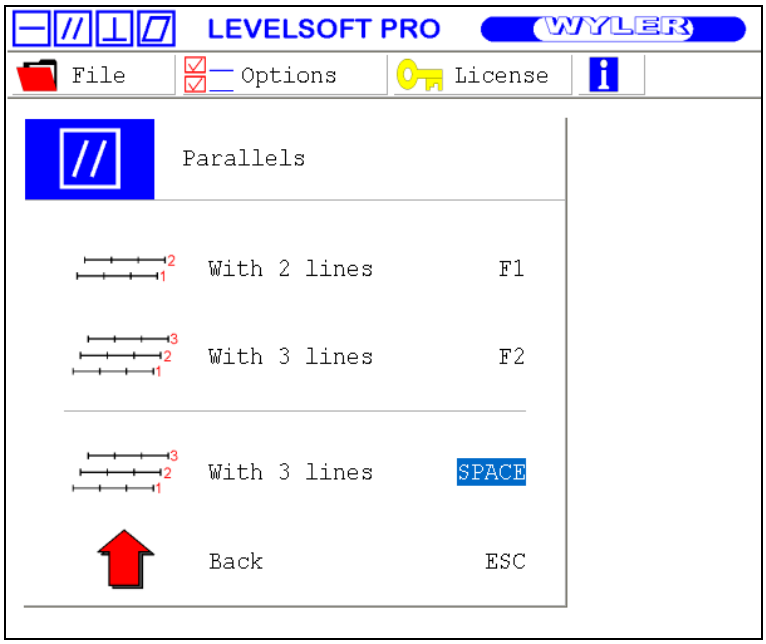
The following dialogue box is seen with the listing of the possibilities of the objects:

- **LINE**
  Measurement of lines
- **LINE WITH TWIST**
  Measurement of lines with twist
- **PARALLELS**
  Measurement of up to 3 parallels
- **PARALLELS WITH TWIST**
  Measurement of up to 3 parallels with twist
- **SURFACE (Flatness)**
  Measurement of surfaces, respectively flatness
- **SQUARENESS** (Measurement of right angle) Measurement of 90 deg. Angles
- **LINE ABSOLUTE**
  Measurement of a line with absolute values

Chose now <PARALLELS> / [F3]

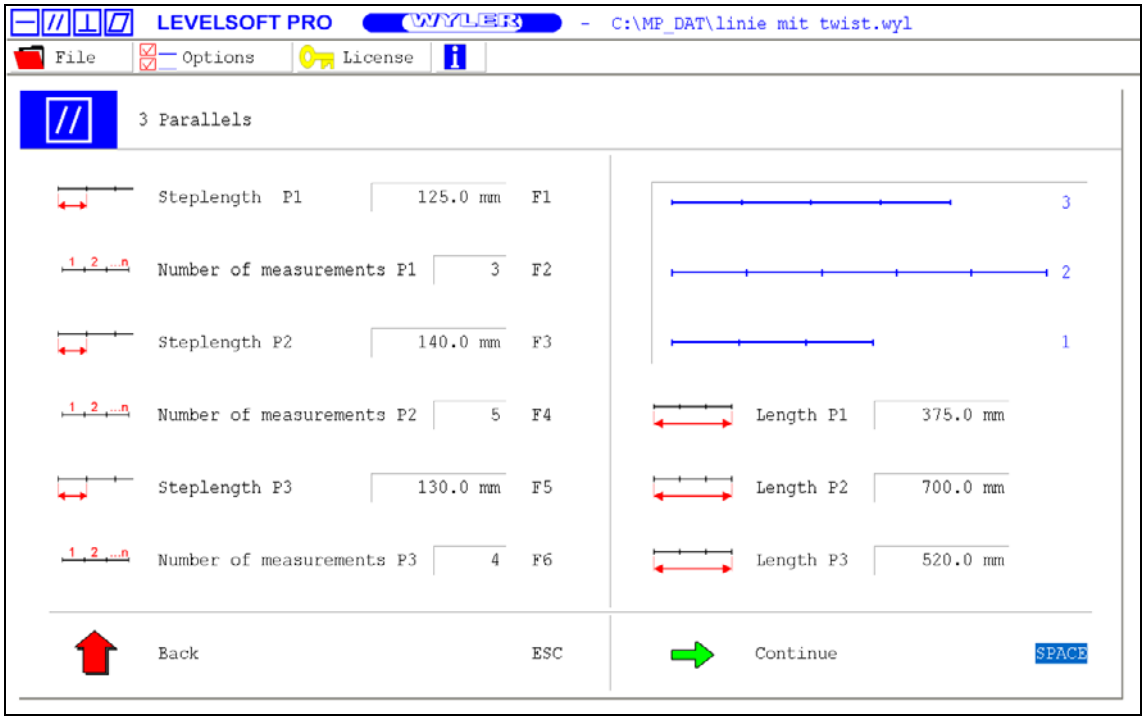
The following choice appears, Parallels:

- With 2 Lines
- With 3 Lines



In the example we chose <With 3 Lines> / [F2]

The mask for entering the parameters is displayed.



The following parameters must be entered now:

- Step length P1: 125mm
- Number of measurements P1: 3
- Step length P2: 140mm
- Number of measurements P2: 5
- Step length P3: 130mm
- Number of measurements P3: 4

Different step lengths are only admitted if these are possible with one only measuring base.

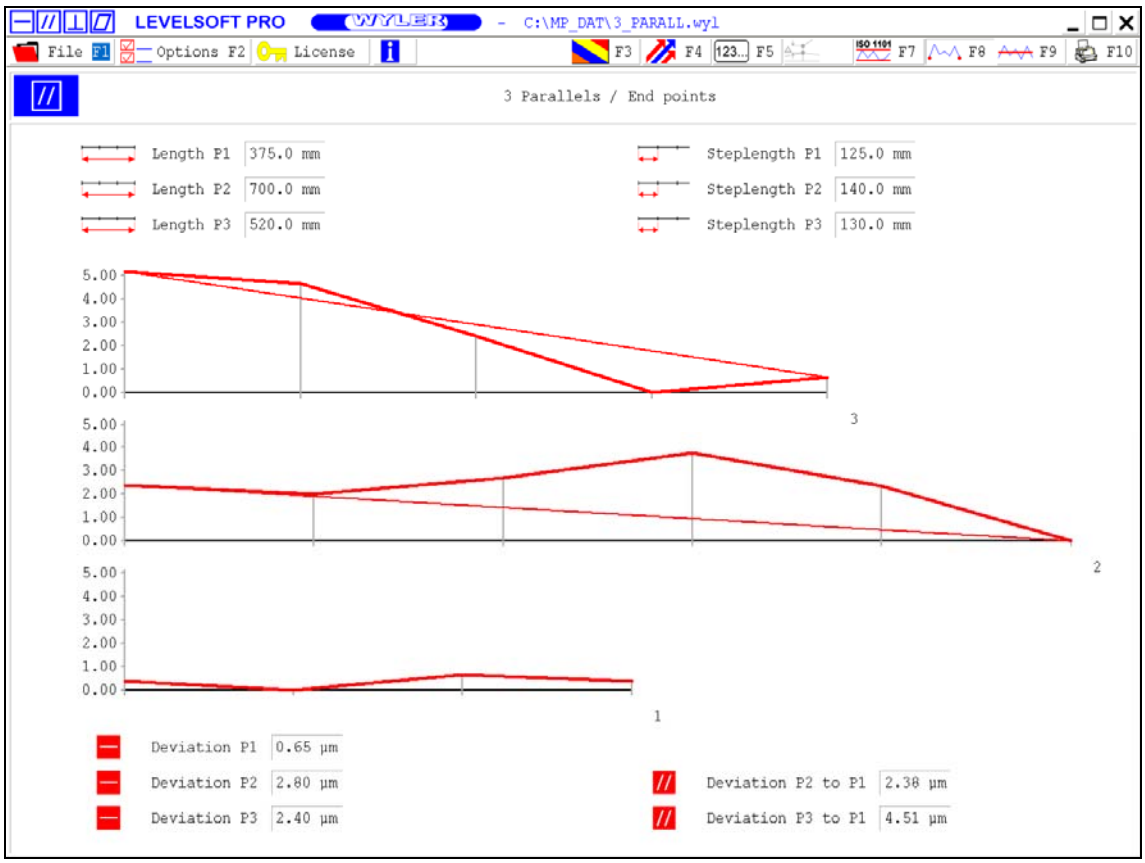
The data is displayed in the monitor (top right) and can be accepted with <Continue> / [SPACE]

The other steps are identical to measuring a line:

- Way of measuring
- Limit of variation
- Surveillance of drift
- Start measurement, with/without saving the measuring pattern

is identical to measuring a line

After the last measurement has been taken automatically the following graph of the measured lines is displayed:



The following information is seen:

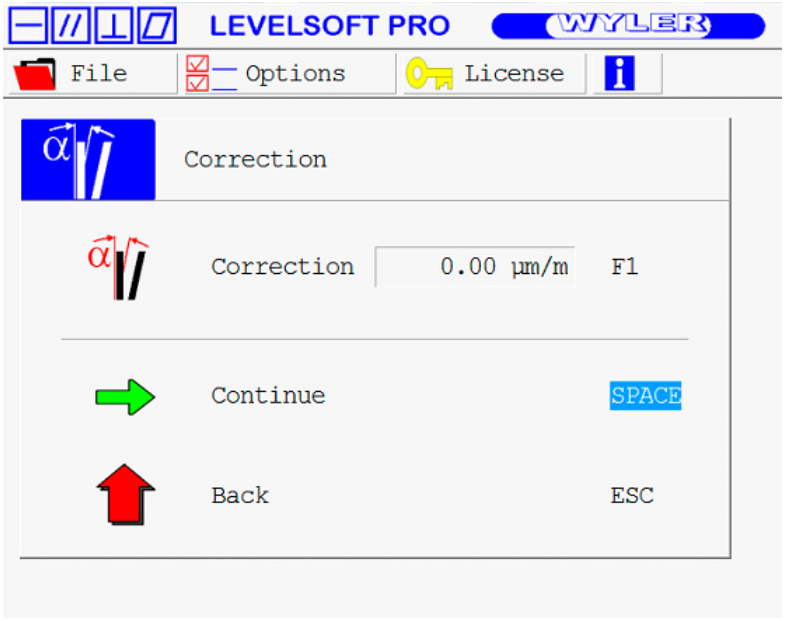
- Graph: Shows the straightness respectively the parallelism of the measured lines in graphical form
- 3 Parallels /End points: The display shows that the first parallel has been aligned according to the **"End points"** method
- Error P1: Straightness error of the first parallel
- Error P2: Straightness error of the second parallel
- Error P3: Straightness error of the third parallel
- Error P2 to P1: Error of the first parallel to the second parallel
- Error P3 to P1: Error of the first parallel to the third parallel
- Length P1: Total length of parallel 1
- Length P2: Total length of parallel 2
- Length P3: Total length of parallel 3
- Step length P1: Step length of parallel1
- Step length P2: Step length of parallel2
- Step length P3: Step length of parallel3

The following steps:

- Display in colour [F3]
- Alignment methods for the first parallel
- Switch between graphical display and measuring pattern [F4]
- Display measured values [F5]
- Printing

are identical to the measurement of a "LINE".

Special option when measuring 2 parallels.
Before starting the measurement LEVELSOFT PRO offers a correction window. Here an offset can be entered. This offset will be considered when calculating the parallelism.
Purpose: When e.g. two opposite vertical parallels must be measured a special measuring instrument with two vertical bases or a frame base must be used. This correction option allows considering the error of parallelism between the measuring bases of the instrument.



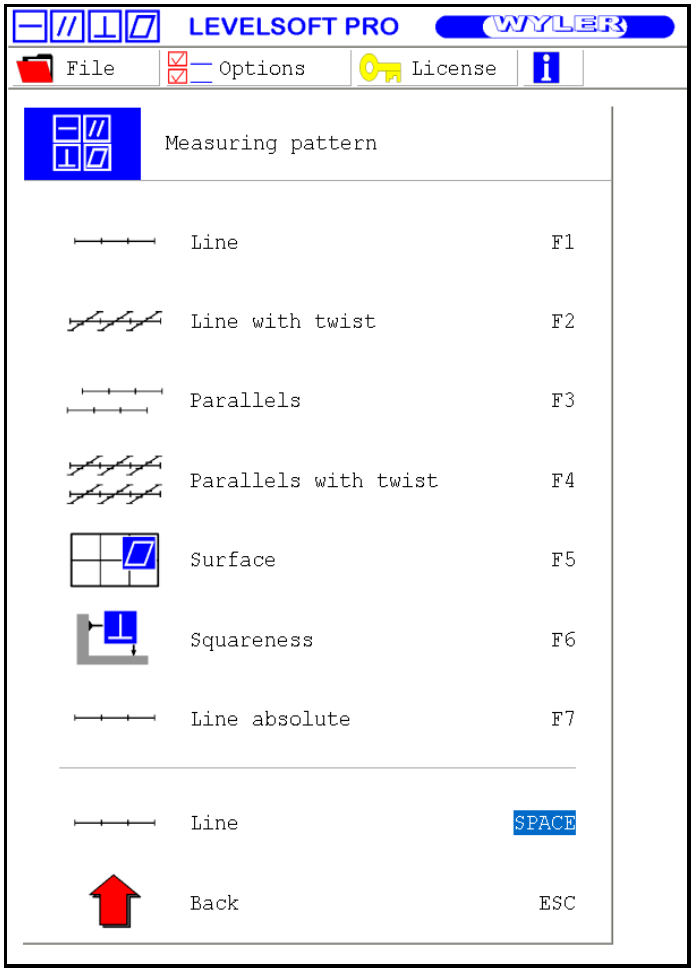
5.5 Measurement of parallels with twist

Up to 3 parallel lines can be measured. The measuring procedure and the description of the various parameters are shown with a simple example of measuring parallel lines with twist.
Most of the actions are identical to the measurement of a line and therefore not specifically repeated.

Example:
Measurement of a granite straight edge with a total length of 650 mm, three parallels with TWIST, differential measurement with two instruments

- Two instruments connected to a PC via Levelmeter 2000
- Line 1: 3 Steps at 125mm
- Line 2: 5 Steps at 140mm
- Line 3: 4 Steps at 130mm
- For all lines: Twist is 2 x 120mm / Twist "RIGHT OF STEP"
- Base length instruments: 150mm

Just follow the same procedure as when measuring a line



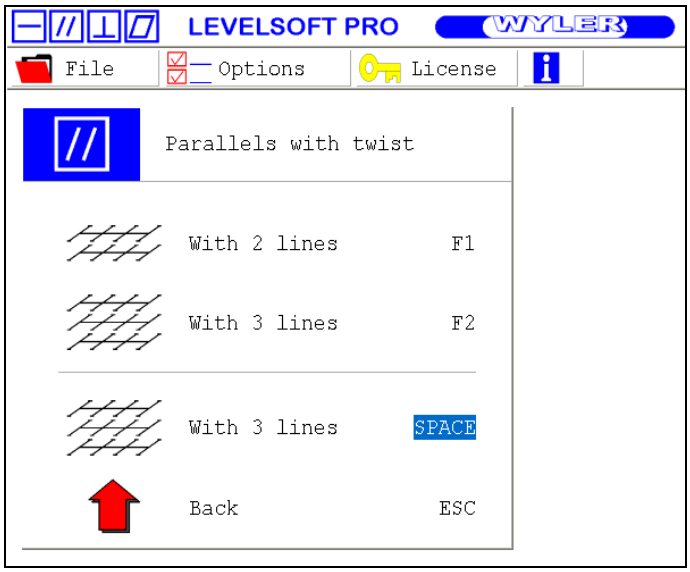
The following dialogue box is seen with the listing of the possibilities of the objects:

- **LINE**
  Measurement of lines
- **LINE WITH TWIST**
  Measurement of lines with twist
- **PARALLELS**
  Measurement of up to 3 parallels
- **PARALLELS WITH TWIST**
  Measurement of up to 3 parallels with twist
- **SURFACE (Flatness)**
  Measurement of surfaces, respectively flatness
- **SQUARENESS** (Measurement of right angle) Measurement of 90 deg. Angles
- **LINE ABSOLUTE**
  Measurement of a line with absolute values

In our example chose <Parallel with twist> / [F4]. The entering mask for the parameters appear

The following choice appears, Parallels:

- With 2 Lines
- With 3 Lines



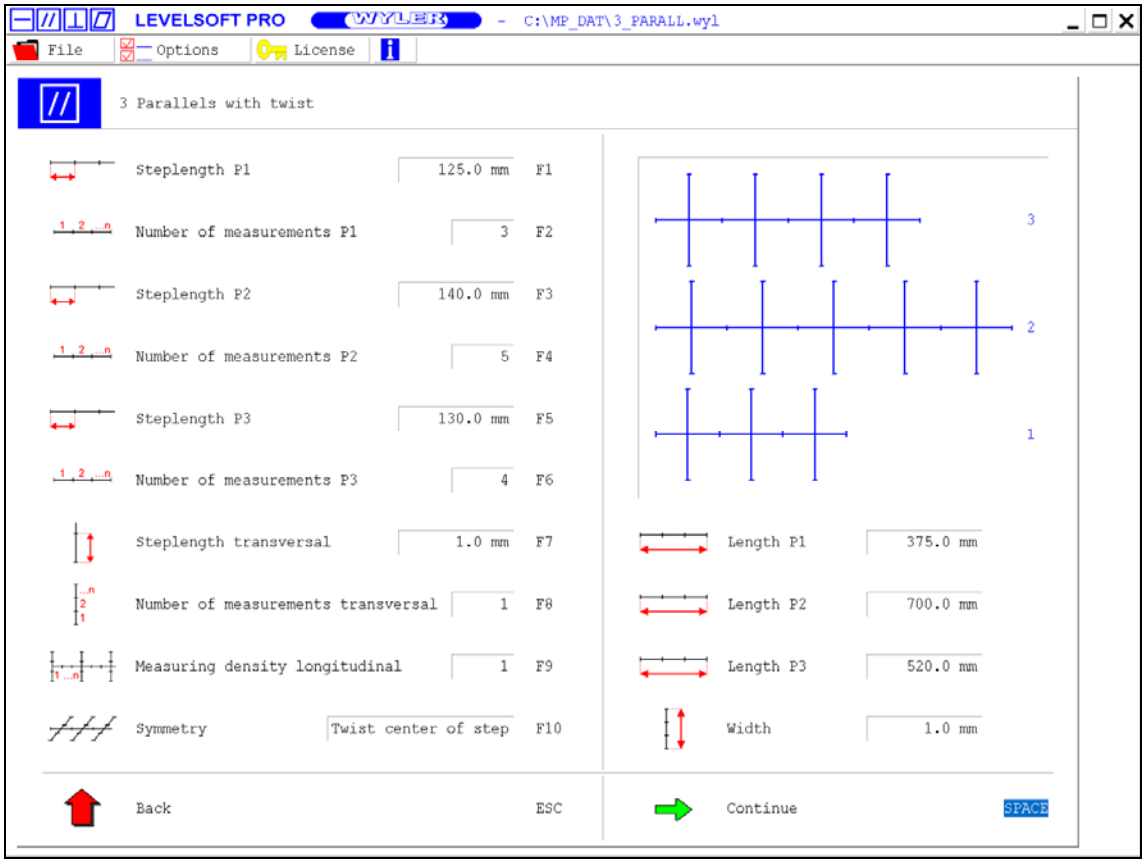
In the example we chose
< With 3 Lines> / [F2]

The mask for entering the parameters is displayed.

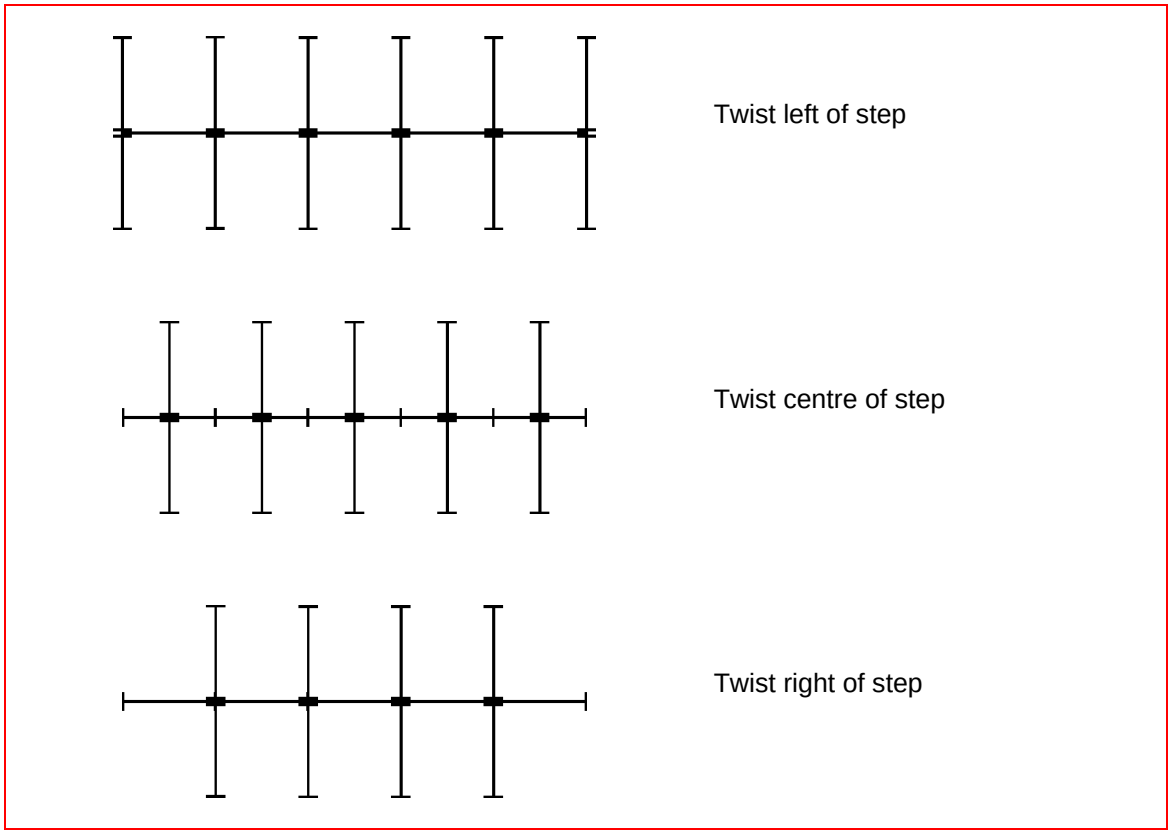
The following parameters must be entered now:

- Step length P1: 125mm
- Number of Measurements P1: 3
- Step length P2: 140mm
- Number of Measurements P2: 5
- Step length P3: 130mm
- Number of Measurements P3: 4
- Step length twist: 120mm
- Number of Measurements transversal: 1
- Symmetry: "Twist End measurement"

Different step lengths are only admitted if these are possible with one only measuring base.



Remarks to the question "Twist symmetrical?"



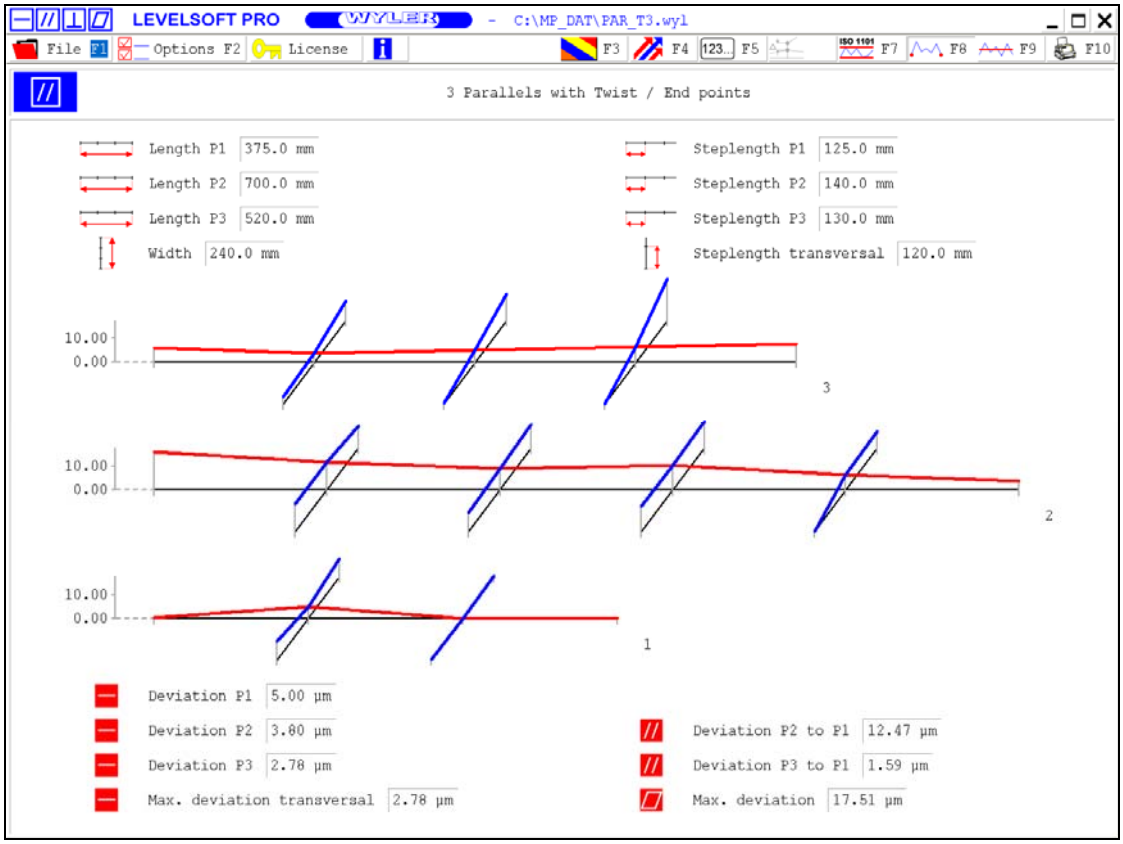
The data is displayed in the monitor (top right) and can be accepted with <Continue> / [SPACE]

The other steps are identical to measuring a line:

- Way of measuring
- Limit of variation
- Surveillance of drift
- Start measurement, with/without saving the measuring pattern

is identical to measuring a line

After the last measurement has been taken automatically the following graph of the measured line is displayed:



The following information is seen:

- Graph: Shows the straightness respectively the parallelism of the measured line with twist in graphical form
- 3 Parallels with twist /End points The display shows that the parallels are aligned according to the **"End points"** method
- Error P1: Straightness error of the first parallel
- Error P2: Straightness error of the second parallel
- Error P3: Straightness error of the third parallel
- Error P2 to P1 Error of the second parallel to the first parallel
- Error P3 to P1 Error of the third parallel to the first parallel
- Maximum error transversal: Maximum error of the twist measurement. Maximum flatness error of the faultiest transversal line, provided that this line consists of more than one step.
- Maximum error Total max. error of **flatness of the object**
- Length P1: Total length of parallel 1
- Length P2: Total length of parallel 2
- Length P3: Total length of parallel 3
- Step length P1: Step length of parallel1
- Step length P2: Step length of parallel2
- Step length P3: Step length of parallel3
- Width: Width transversal
- Step length transversal: Step length transversal (twist)

The following steps:

- Display in colour [F3]
- Alignment according to the "End points" method: The first parallel will be aligned so that both end points are at the same level, the other parallels are pivoted by the same amount. The first transversal line is pivoted to bring both ends to the same level and all other transversal measurements are pivoted by the same amount
- Switch between graphical display and measuring pattern [F4]
- Display measured values [F5]
- Printing

are identical to the measurement of a "LINE".

5.6 Measurement of Flatness

5.6.1 Surface "Surface Grid (WYLER)" DIN 876 / Part 1 (Grid)

Remarks concerning the flatness measurement:

a) Standards

Please consult DIN 876 / Part 1, when measuring flatness

b) Measuring steps

The object to be measured must be adjusted horizontally in both directions (longitudinal and transversal) as well as possible (within approx. 50 µm/m). If not done so measuring errors may occur if the measuring instrument is not placed exactly in line with the measuring direction.
The object must now be divided in the measuring step length. The step length has to be such that an equal dimension of overlapping of the base length with each step is possible. At the same time the optimal step length as described earlier must be considered.
The best possible step length when using a 150 mm base is 126 mm.
As a guideline it should be noted that the worse the surface quality (roughness, buckling) the more important is a precise overlapping in order to avoid measuring errors. When calculating the measuring steps it is important to make sure that the base as a whole comes to lay on the surface when placed at the first and last measuring position (no protrusion) as this would also cause unacceptable measuring errors.
The grid is to be marked on the surface plate with a pencil that does not apply a thick layer. This is especially important doing high precision measurements.

Example:

Measuring object: Granite surface plate 1200 x 800 mm

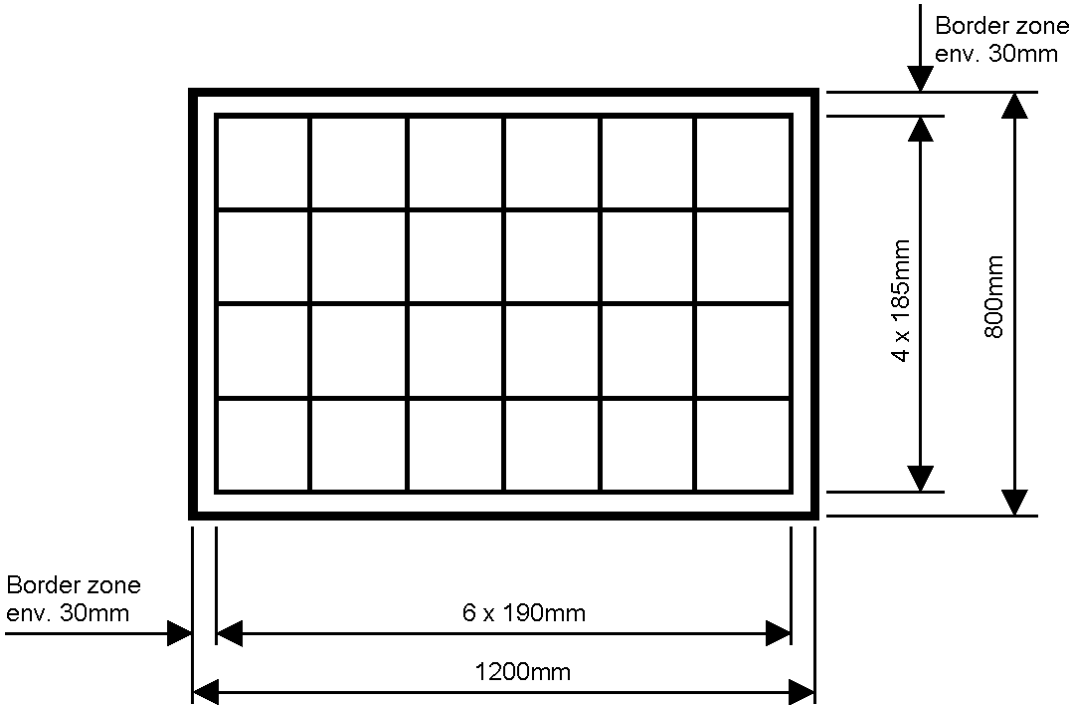
Measuring instrument:	Minilevel or Leveltronic, horizontal model Base length of the instrument is: 200 mm optimal step length is 170 mm
Pattern of measurement:	Surface Grid (WYLER)
Step length longitudinal:	190 mm
Step length transversal:	185 mm
No. of longitudinal lines:	5
No. of transversal lines:	7

(Calculation of the grid see below)

Remarks concerning the pattern of measurement "SURFACE"

Four different patterns for measuring flatness are available:

1. Rectangle	see chapter 5.6.2 Rectangle
2. Surface grid (WYLER)	this chapter
3. U-Jack	see chapter 5.6.3 Measuring of surfaces according to the method "US Union - Jack"
4. Partial surface	see chapter 5.6.4 Measurement of partial surfaces



In our example the calculation was based on the border zone of 20, resp. 30 mm on the side. The remaining distance is divided by the optimal step length, and then the figure set to either the next higher or lower round figure. The originally defined remaining distance must now be divided by the new fixed number of steps whereas the newly calculated figure is the step length to chose.

1200 mm - (2 x 30 mm) = 1140 mm
1140 mm / 170 mm = 6.7 steps = 6 Steps; 1140 mm / 6 = **190 mm step length longitudinal**

The same method is to be applied for the other direction with a length of 800 mm

On the side of the base the step length may be marked. Also the middle of the base may be marked at the front and at the end. By doing so it is assured that the measuring instrument is always placed correctly at the spot required.

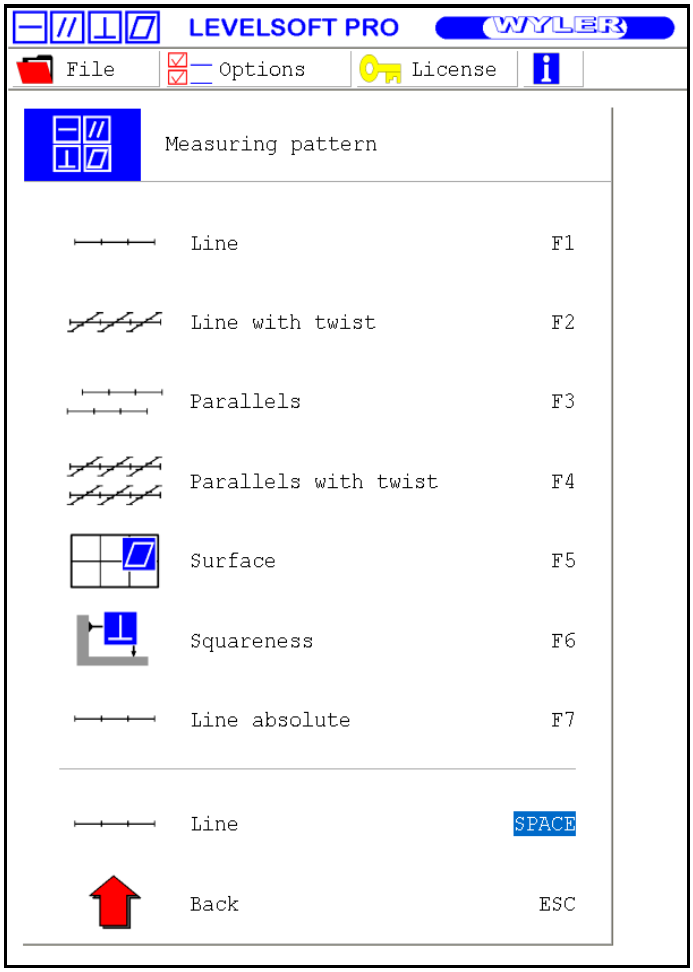
See also DIN 876 / Part 1

Optimal step length in relation to the base length

Length of measuring base	Optimal measuring step length	Recommended range of measuring step length
110 mm	90 mm	85 ... 105 mm
150 mm	126 mm	120 ... 145 mm
200 mm	170 mm	160 ... 190 mm

As an alternative the "Grid Proposal" can be used for a possible layout of the grid to be measured. See details in the following example.

Just follow the same procedure as when measuring a line



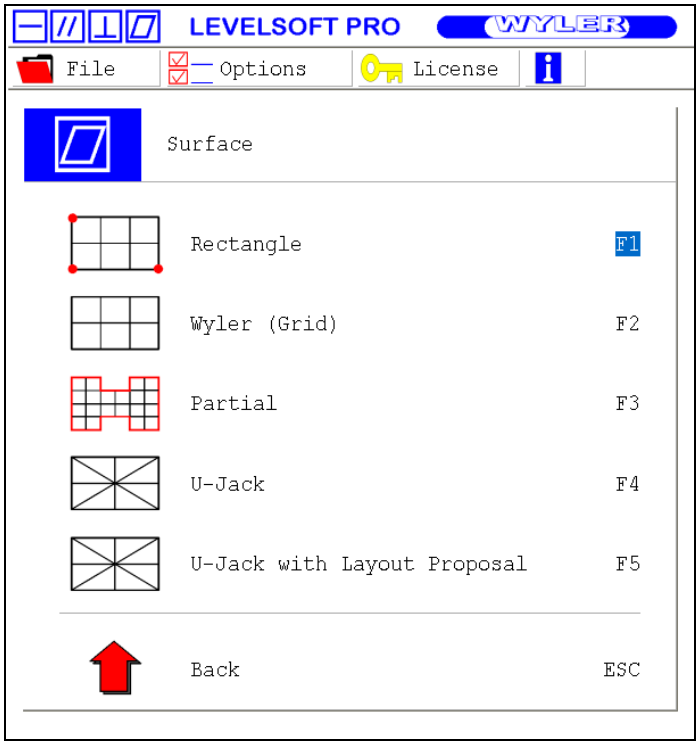
The following dialogue box is seen with the listing of the possibilities of the objects:

- **LINE**
  Measurement of lines
- **LINE WITH TWIST**
  Measurement of lines with twist
- **PARALLELS**
  Measurement of up to 3 parallels
- **PARALLELS WITH TWIST**
  Measurement of up to 3 parallels with twist
- **SURFACE (flatness)**
  Measurements of surfaces, respectively flatness:
  - surface
  - rectangle => alignment only according to "end points" in X- and Y-direction“
  - U-Jack => alignment specified by the standard / US-Governmental requirements GGG-P-463 c
  - U-Jack with **layout proposal** => alignment specified by the standard / US-Governmental requirements GGG-P-463 c
  - Partial => Measurement of partial surfaces based on the pattern "surface WYLER"
- **SQUARENESS** (Measurement of right angle) Measurement of 90 deg. Angles
- **LINE ABSOLUTE**
  Measurement of a line with absolute values

In our example we chose Surface / [F5]

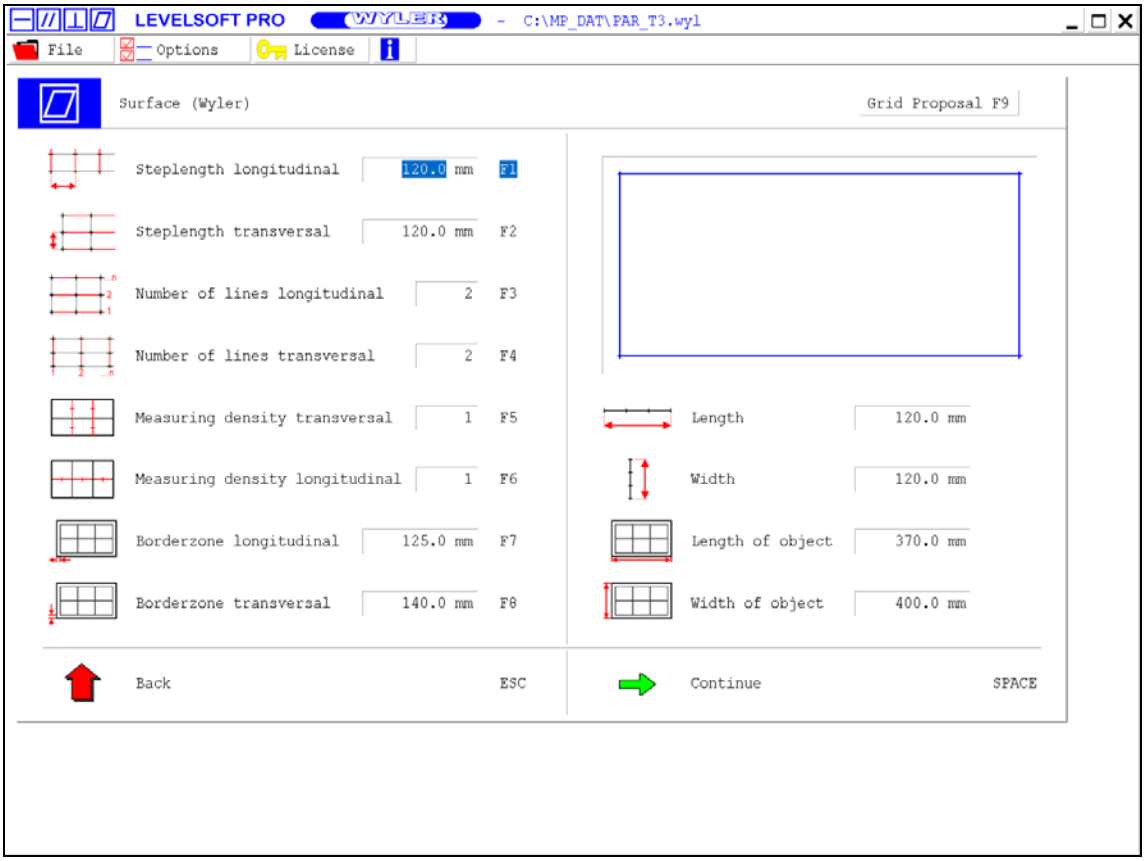
A number of three different options are available

- **Rectangle**
  The measured object is aligned in a way that the two endpoints of the first longitudinal line and the two endpoints of the first transversal line are on the same level.
- **Surface WYLER** / GRID
  Standard-flatness measuring method using a grid
- **U-Jack** / US-Standard "GGG – P – 463 c"
  This method is mainly used in the US and in the UK. The mayor disadvantage compared with the “WYLER” method according to DIN 876 / Part 1, is the fact that the total surface of the object is not covered optimally.
- **Partial**
  Partial surface based on the measuring object "Surface WYLER"
  This object makes sense to chose, when some obstacles are in the surface (Cut out, etc.)



For our example we chose <WYLER> / [F2]

The previously defined measuring parameters can be entered now in the respective mask.



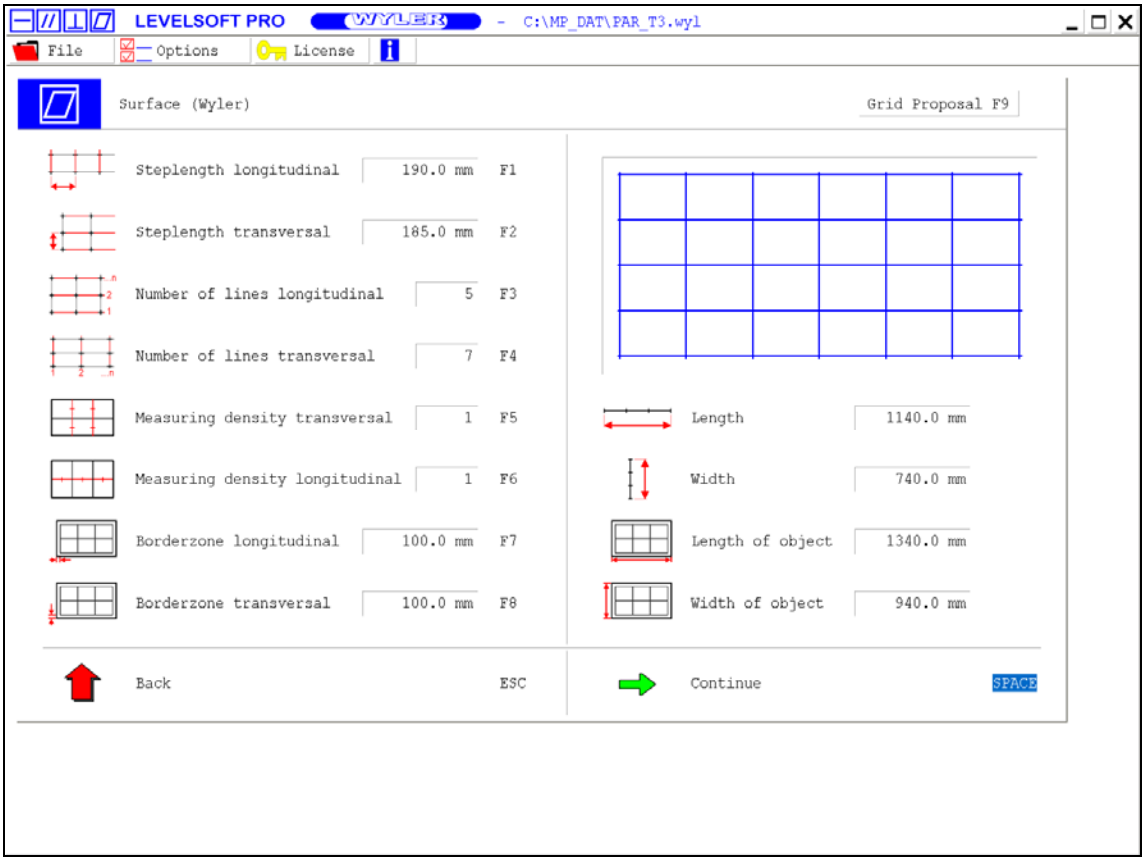
Two options are possible for the definition of the grid layout.

A) Direct entering of the previously defined/calculated values, such as step length, border zone etc.
B) Automatic definition of the required parameters like the step length, border zone etc. by using the button <Grid Proposal>

A. Direct entering of the previously defined/calculated values, such as step length, border zone etc.

The following parameters must be entered now:

- Step length longitudinal 190mm
- Step length transversal: 185mm
- Number of lines longitudinal: 5
- Number of lines transversal: 7
- Measuring density longitudinal: 1
- Measuring density transversal: 1
- Border zone to the first line transversal 30 mm
- Border zone to the first line longitudinal 30 mm

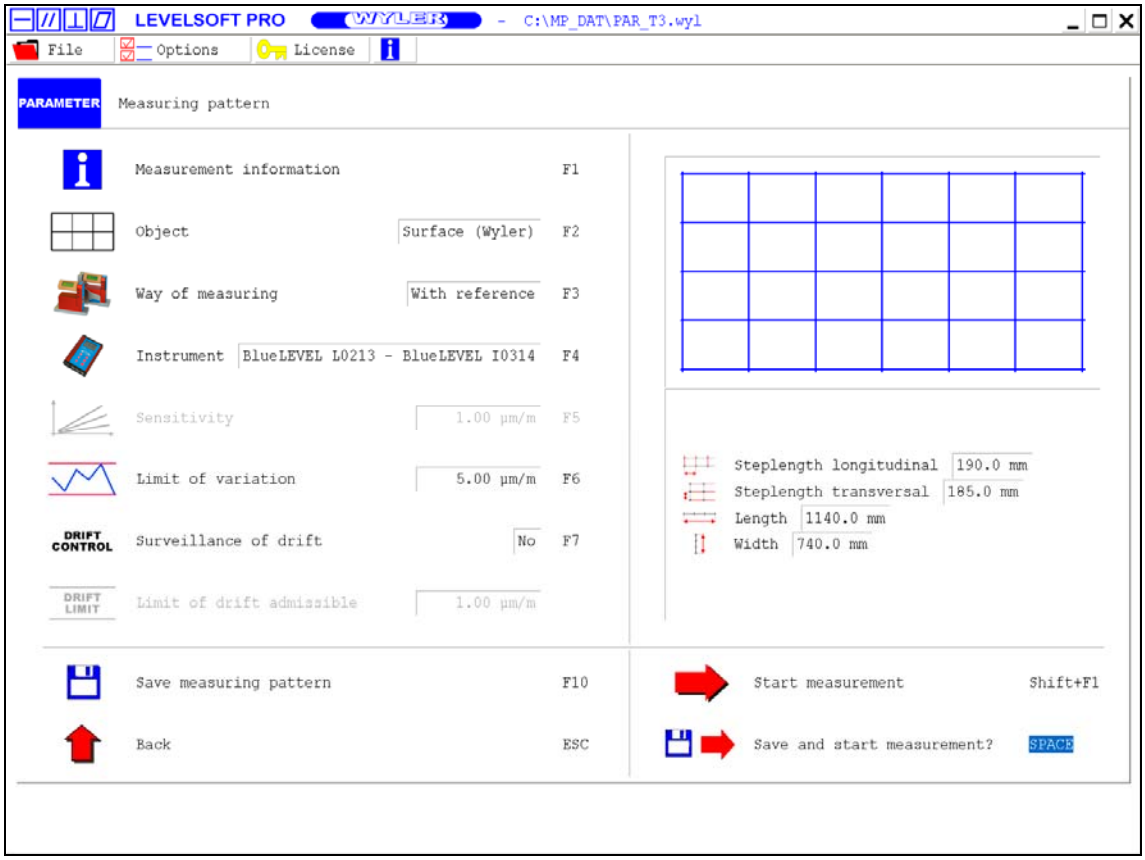


The data is displayed in the monitor (top right) and can be accepted with <Continue> / [SPACE]
The other steps are identical to measuring a line:

- Way of measuring
- Limit of variation
- Surveillance of drift
- Starting the measurement with /without saving of the measuring pattern

---

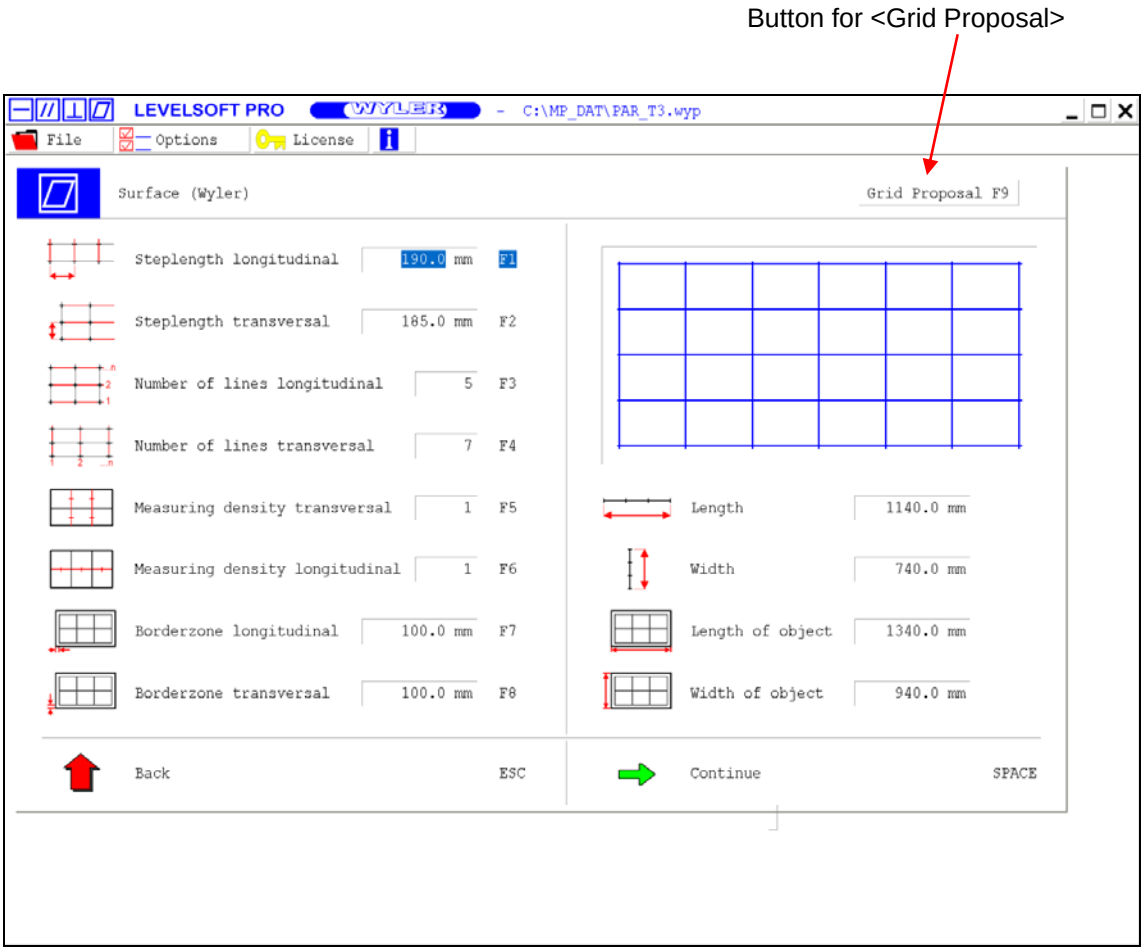
Remarks concerning the border zone longitudinal /transversal:
The smallest possible border zone is 22.5 mm. This is half of the base width of our instruments. This value can not be reduced.



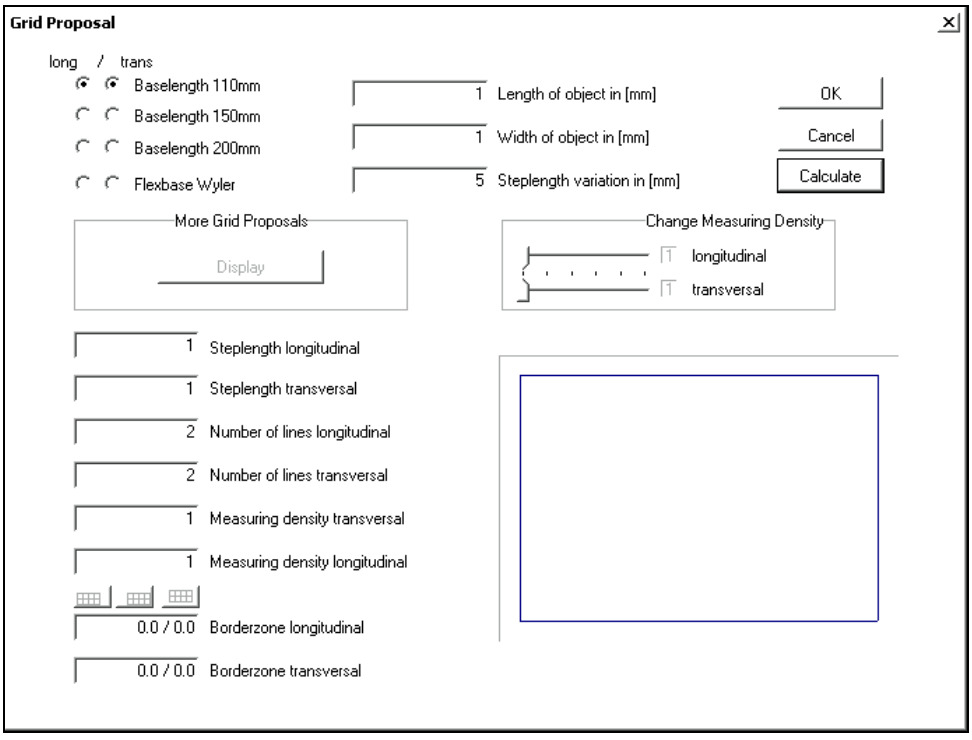
The measurement can now be started by using <Start measurement> / [F11]

B. Automatic definition of the required parameters like the step length, border zone etc. by using the button <Grid Proposal>

In the upper right corner a button is seen <Grid Proposal> / [F9], by using this button a proposal will be automatically produced after entering a number of basic data.

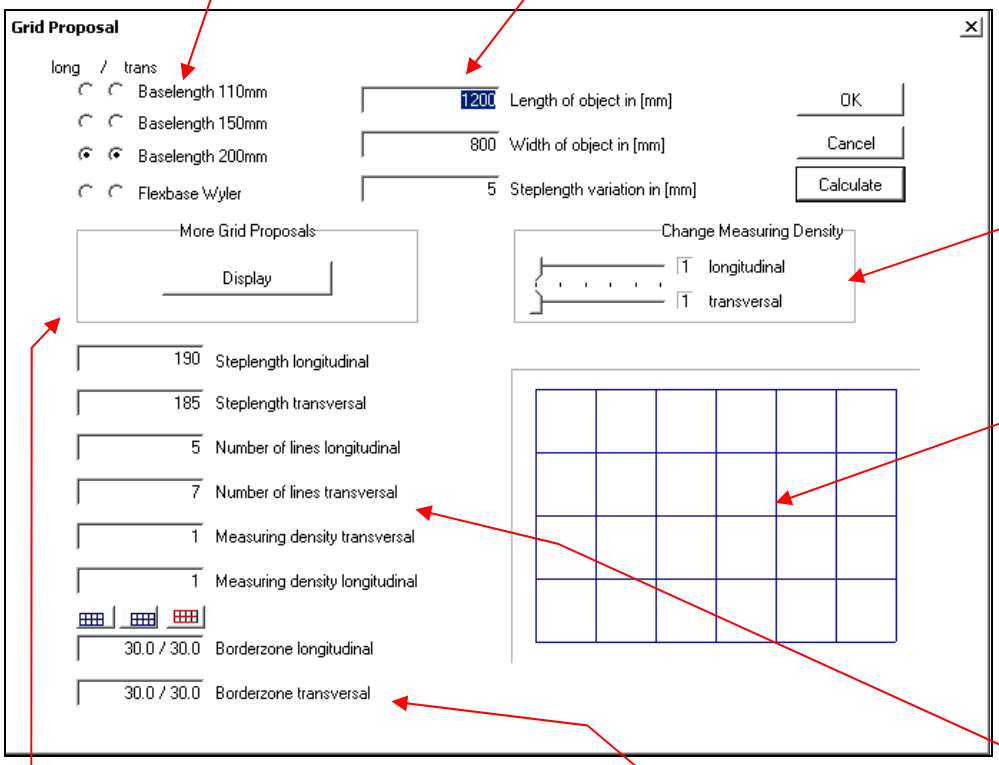


After pressing the button <Grid Proposal> / [F9] the following dialogue box appears:



Entering the size of the available measuring bases (in our example 200 mm) longitudinal, transversal

- Entering the size of the object, length and width.
- Entering the variation of the step length, (default setting 5 mm)



Slide control unit for changing the measuring density (default: 1)

Monitor, displays the proposed set-up graphically

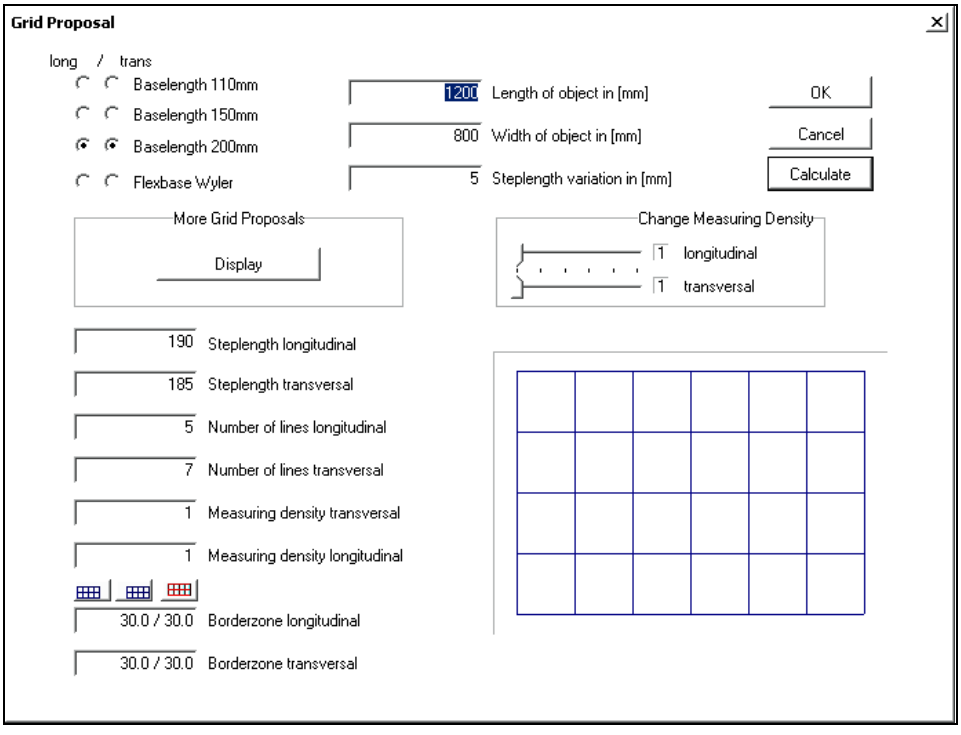
Display of additional grid proposals for longitudinal and transversal directions.

Selection of symmetric or asymmetric measuring set-up (Explanation see Annex **Point 6.3 Measurements with symmetric, respectively asymmetric layout)**

Proposed set-up in numerical form

Procedure of input:

1. Enter the base length of the instrument foreseen for longitudinal and transversal measuring direction
2. Enter the size of the object (length and width)
3. Using <Calculate> will produce a first proposal



In our example in the first proposal a remark is seen by the display of the border zones "Attention border zone!". This means the size of the border zone respectively the dimension from the object's edge to the first measuring line is larger than allowed according to DIN 876.

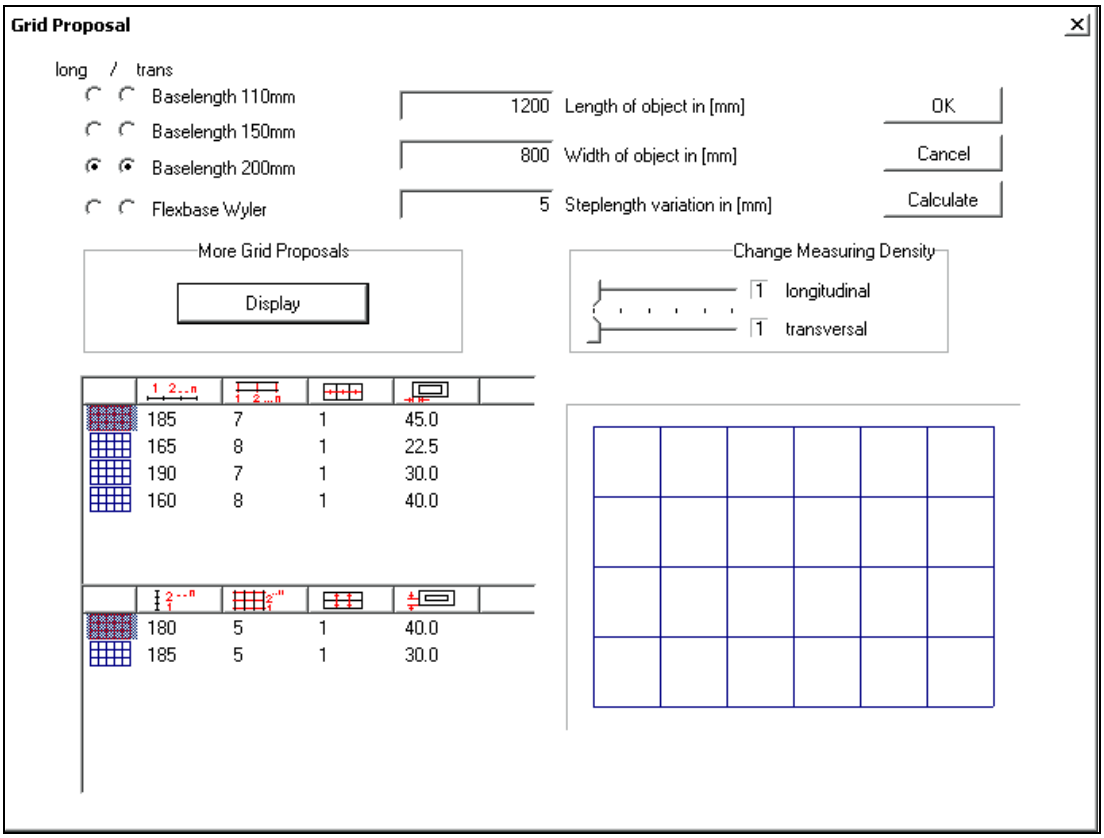
Further procedure:

4. Using the function "More Grid Proposals" a selection of additional grid proposals is displayed. Those proposals which are possible but do not fully comply with the respective standards (Border zone not according to standards) are marked in red. By clicking to the respective column header the data can be sorted according to the values in the respective column.

   Meaning of the different columns (left to right):

   Step length / Number of measurements / Measuring density / Border zone

   The chosen grid proposal should now be marked after checking if the border zone is within the tolerance required.



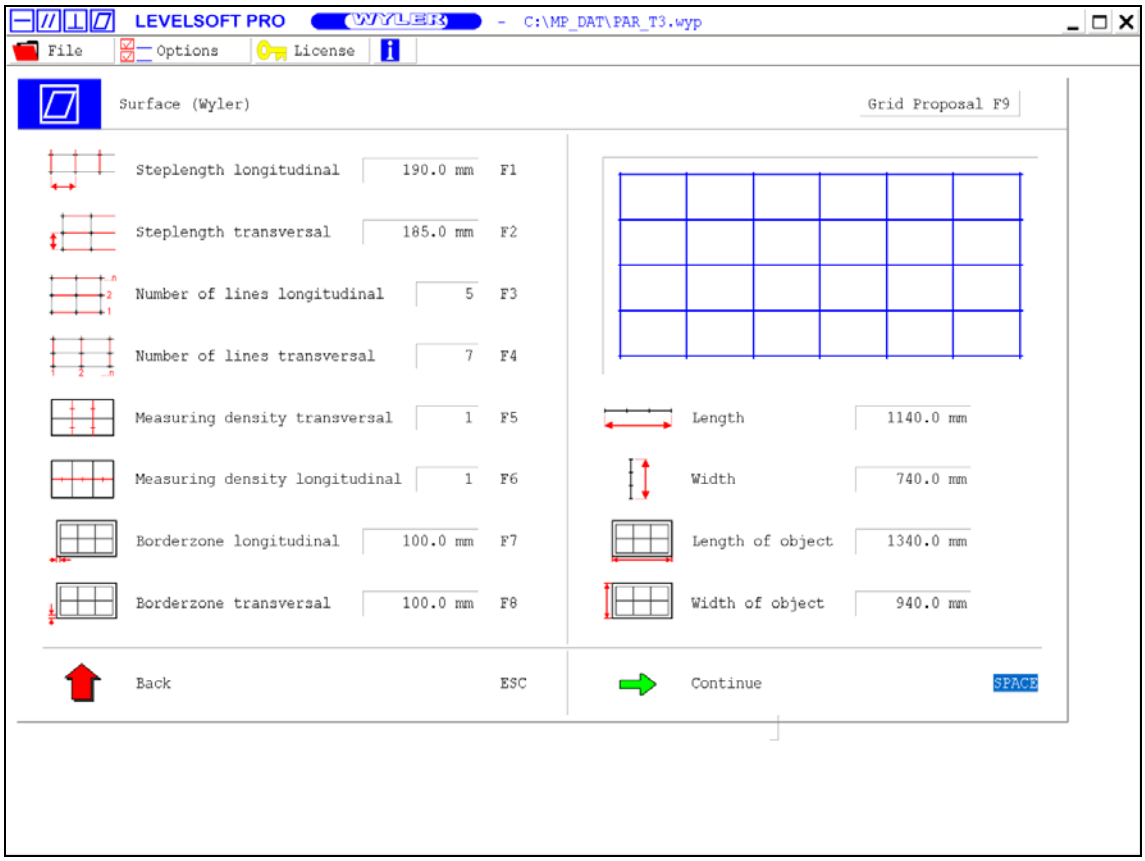
Next step:

5. Using the Slide control unit "Change Measuring Density" long and cross the density may be changed. By doing so new proposals will be computed. Default is that every line longitudinal and transversal is measured.

In our example we do not change the measuring density, we measure all the lines of the grid.

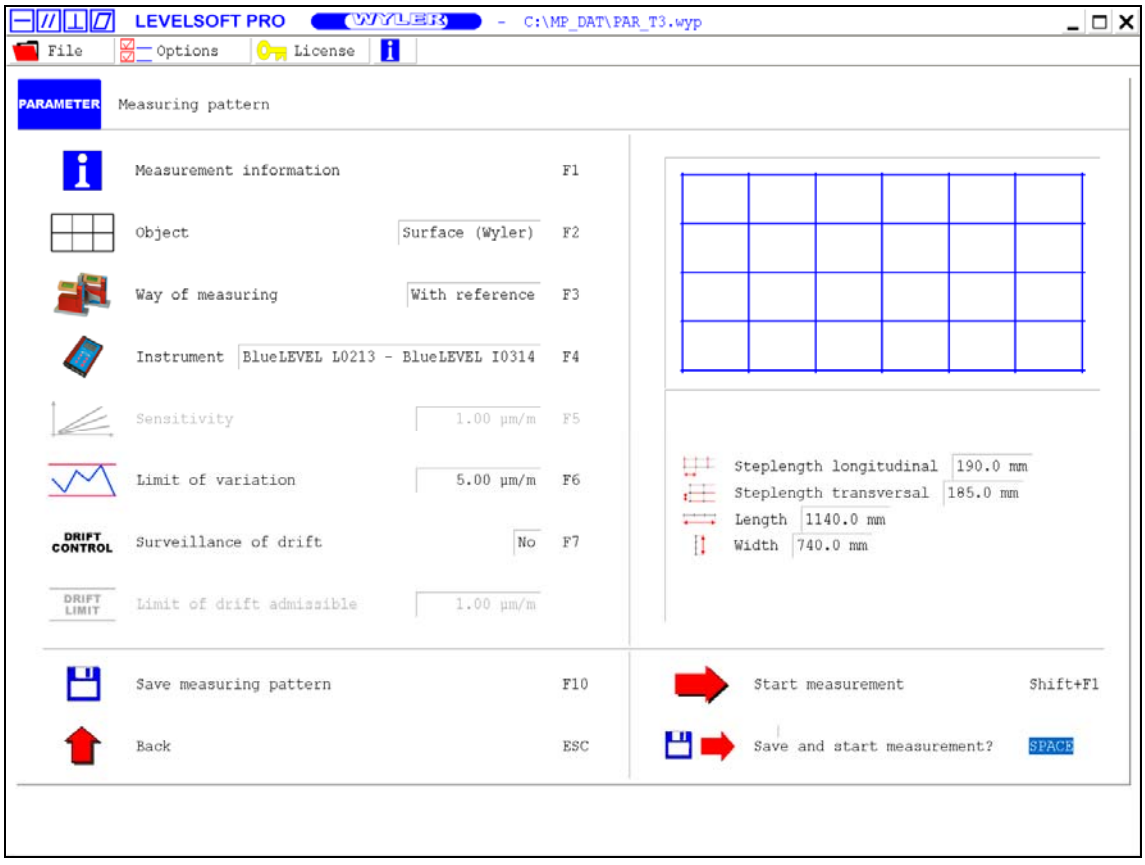
Remarks concerning border zone longitudinal, transversal:
The smallest possible border zone is 22.5 mm. This is half of the base width of our instruments. This value can not be reduced.

Using OK the proposed solution is accepted for continuation in the appearing windows.



The selected values will be incorporated and with <Continue> / [SPACE] the grid layout will be accepted. In case it should not be satisfactory

- individual values can be changed in this window
- the <Grid proposal> / [F9] can be selected from new.

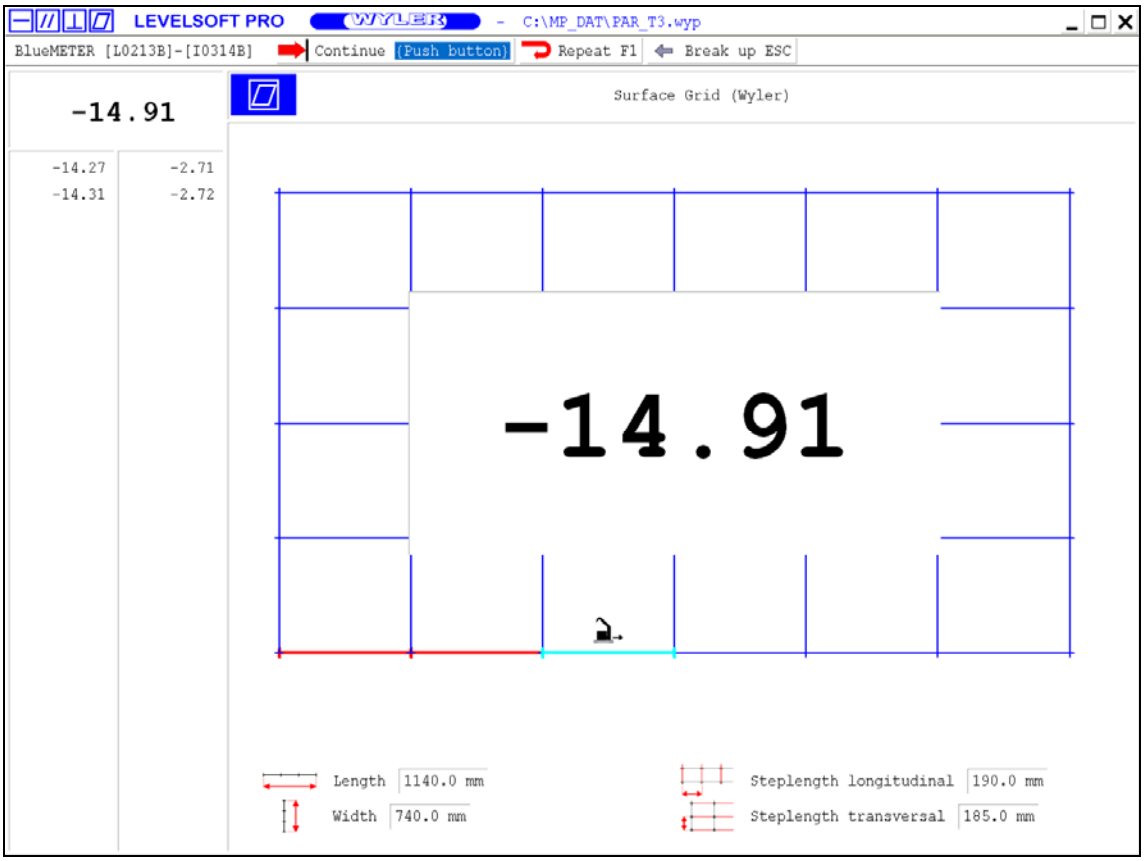


The other steps are identical to measuring a line:

- Way of measuring
- Limit of variation
- Surveillance of drift
- Starting the measurement with / without saving of the measuring pattern

is identical to the procedure of measuring a line.

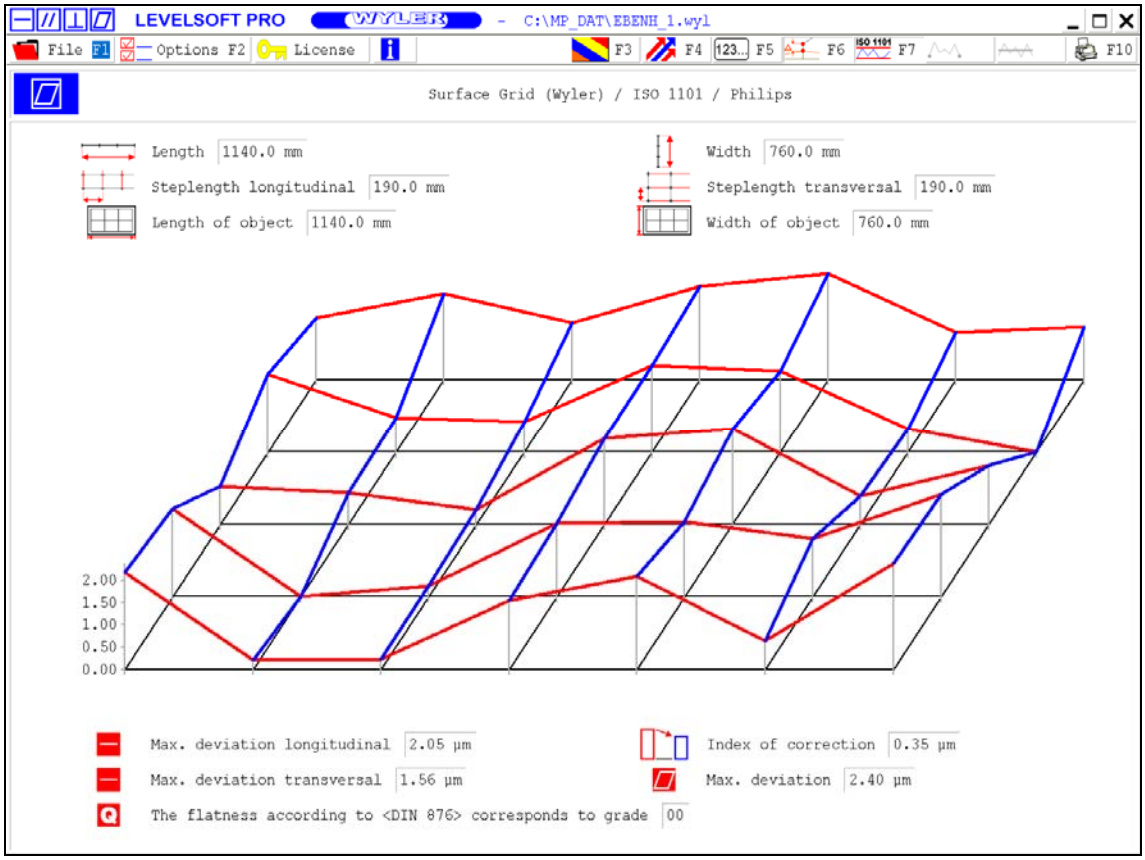
The measurement can now start by using <Start measurement> / [F11] (without saving of the measuring pattern), or using [SPACE] for <Save and start measurement>



After successful collecting of the measurement data the value will be displayed on the screen for checking in large letters. When continuing with the confirmation of the value the displayed figures disappear.

Repeat measurement:

- After the actual collecting of the measured value the measurement can be repeated by using <REPEAT> / [F1]
- After confirming the latest individual measuring value it is possible to use <BACK> / [F2] and then all the values of the whole last measured line can be measured again.



Flatness of the surface according to ISO 1101, with correction of closure errors PHILIPS
The maximum error of the surface is reduced to 2.4 µm. Instead of the closure error the display shows now the "Index of correction" which is corresponding to the standard deviation of all the closure errors.

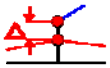
In our example the selected standard is DIN 876 and the quality of the flatness corresponds to grade "00". The standard may be changed by using <Options> / [F7]. The display may also be completely omitted. Additional information to the Quality standards is available in chapter "4.7.17 Changing of flatness standards".

For flatness measurement according to WYLER only the alignment method according to ISO 1101 comes into use!!!

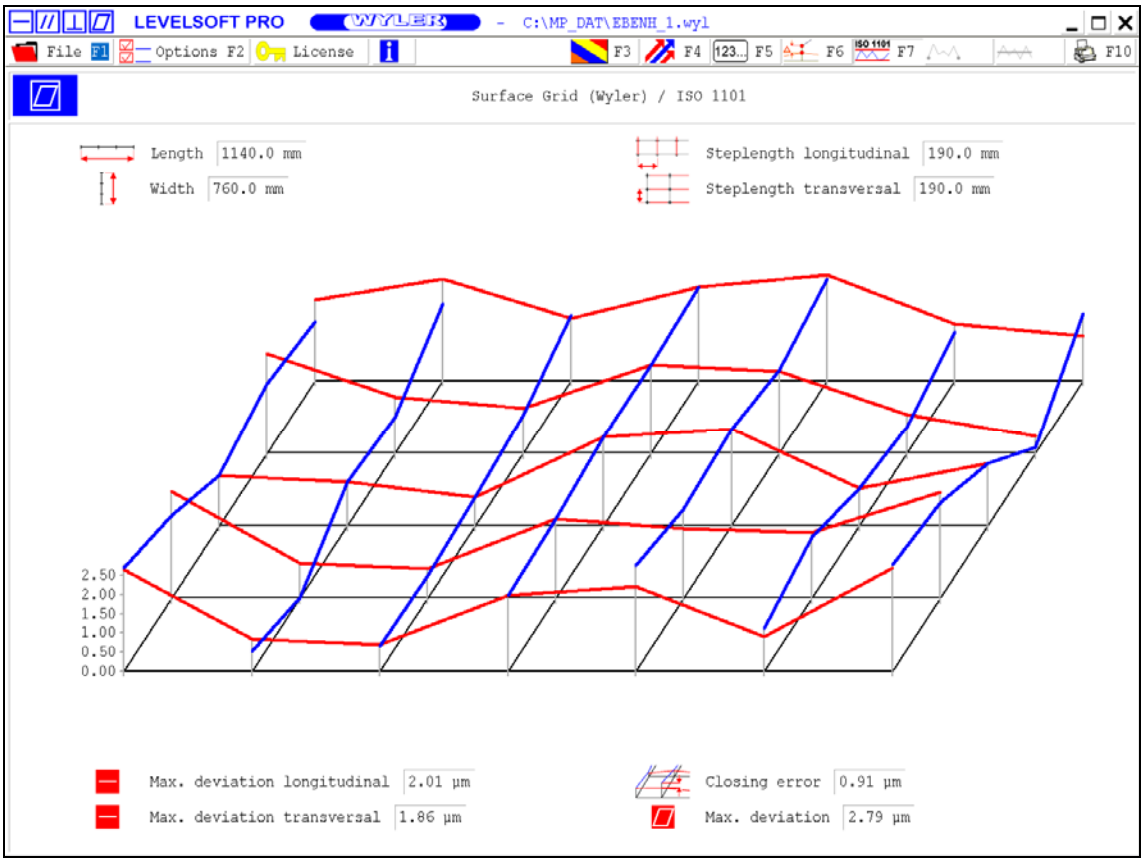
Remarks:
A description of the used quality standards is seen in the Annex "6.2. DETAILED DESPRITION ABOUT "QUALITY STANDARDS" / Quality of the measured object"

The following information is seen:

- Graph: Shows the flatness of the measured object in graphical form
- Alignment method: ISO1101 (surface WYLER grid does not allow any other alignment method)
- Correction of closure error: Philips
- Length: Total length of measured grid
- Width: Total width of measured grid
- Step length longitudinal: Step length longitudinal
- Step length transversal: Step length transversal
- Length of object: Total length dimension of the object
- Width of object: Total width dimension of the object
- Maximum error longitudinal: Maximum error of the lines longitudinal
- Maximum error transversal: Maximum error of the lines transversal
- Index of correction: Index of the closure error correction
- Maximum error: Total flatness error of the measured object
- Flatness grade: Grade of the object according to a specific standard
  Standard selected by <Options> / [F7]

By using the symbol  **F6**

the **closure error** (Philips correcting program) can be shown.



Flatness of the surface, aligned according to ISO 1101, without correction of the closure error.
The maximum flatness error is 2.79 µm, the closure error is 0.91 µm.

The closure error is an indication of the quality of the measurement. The presentation of the quality and the grade is not possible in this display.

Remarks concerning the correction of closure errors:

- After the finishing of the measurement it is important to view the display in profile without the Philips correction. The closure error is an important indication on the quality of the measurement.
- As a general rule the **closure error should not be more than 20% to 25% of the maximum error**. If the maximum error is less than 4 µm the closure error may exceed the above-mentioned values.
- In our example the closure error is 26% of the maximum error (1.07µm related to 4.03µm), however the maximum error is only 4.03 µm therefore the measurement's quality is just acceptable.

The closure error correction according to Philips is a mathematical process in which measuring errors with linear increasing characteristic are visually eliminated.
The index of correction displayed after the corrective action gives an indication of the success of the measurement. (The index of correction is the result of all the standard deviations of the closure errors)

The displayed index of correction must be considered in the definition of the measuring uncertainty

The following steps:

- Display in colour [F3]
- Switch between graphical display and measuring pattern [F4]
- Display measured values [F5]
- Printing

are identical to the measurement of a "LINE".

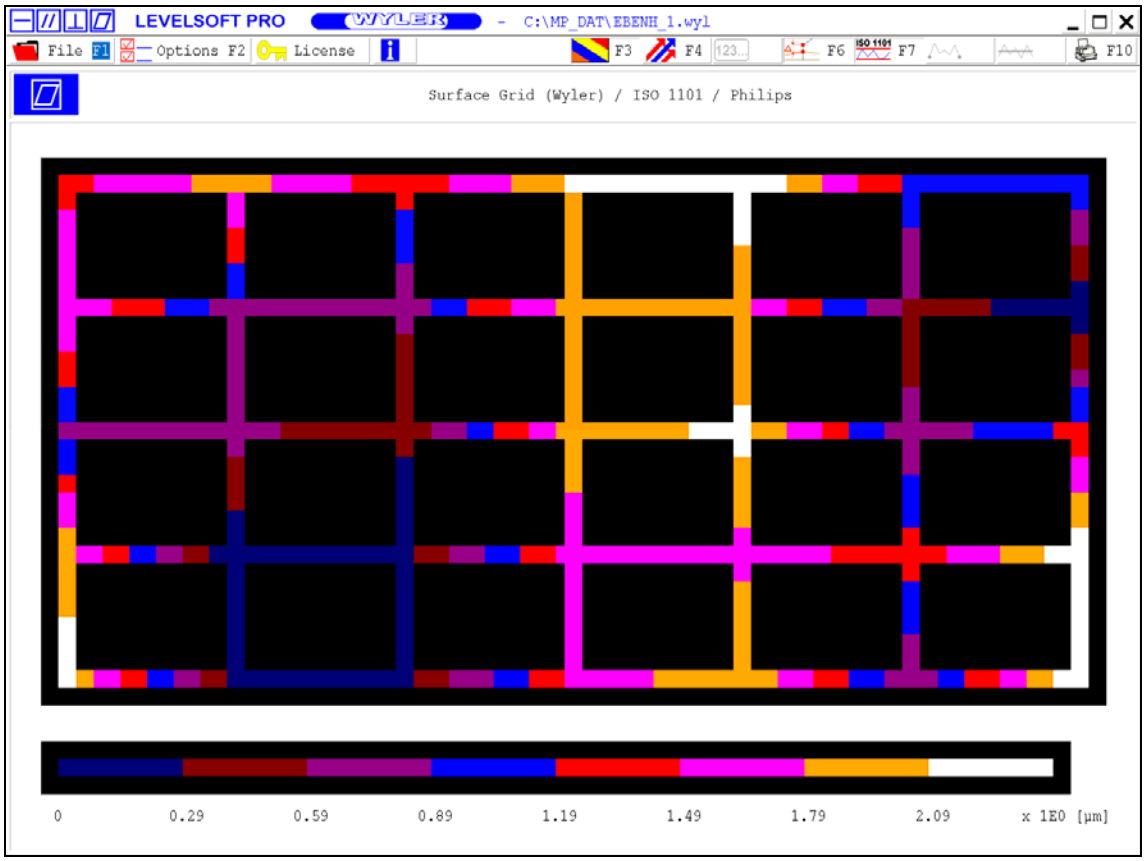
Display in colour graphic / Option 1

Using the key [F3]

/ [F3]

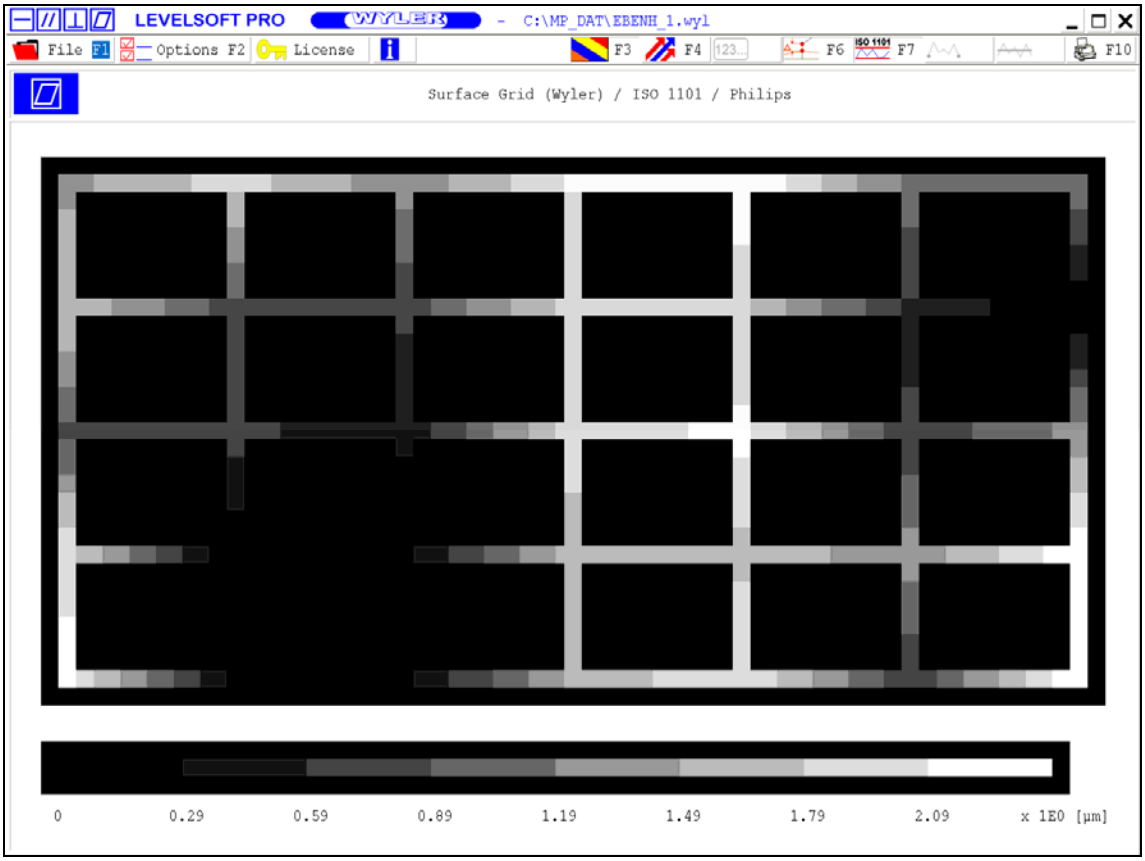
the profile may be displayed in colour

This display is easily memorized, making it especially suitable for applications where corrections are made by manual method (scraping, lapping surface plates). .

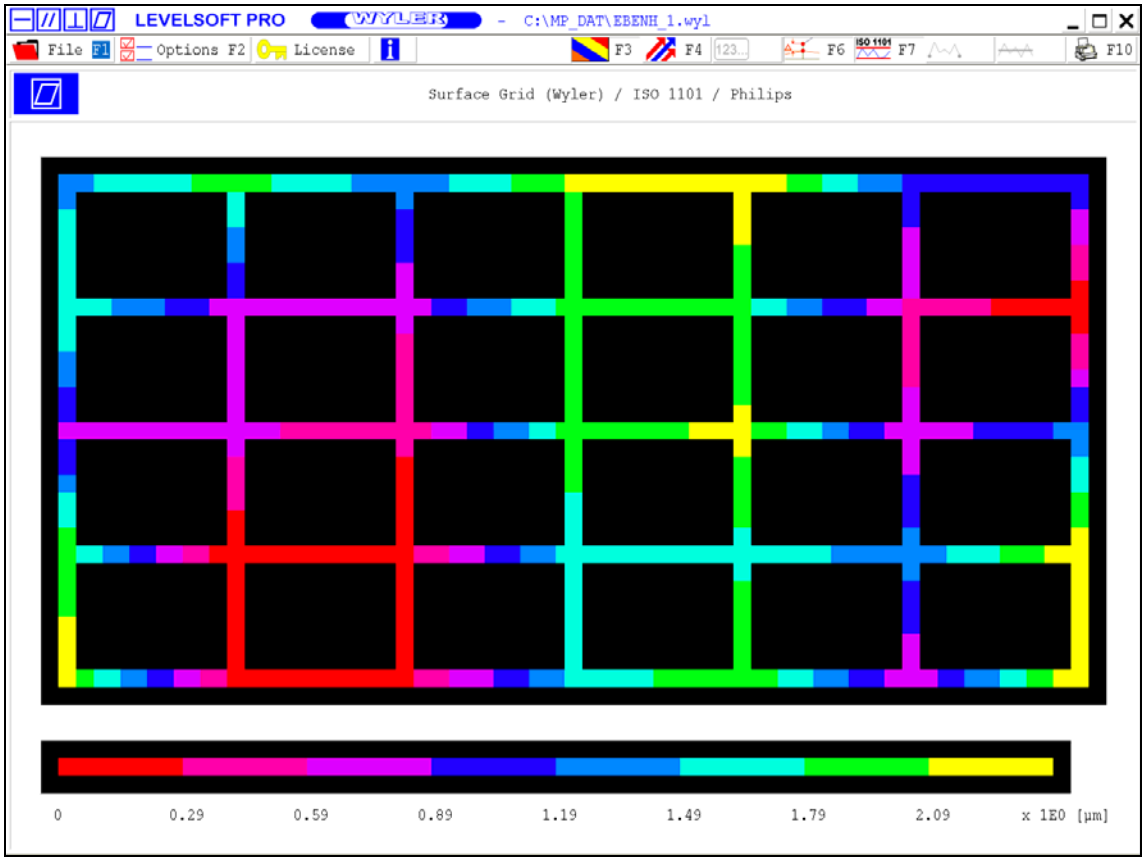


Different colours, each representing one band above the zero-plane, are used to show the errors. In order to evaluate the error-band represented by each colour, a scale is provided on the screen. In case of large errors, the values must be multiplied with the factor shown to the right side of the scale

Display in black and white mode (shades of grey) graphic / Option 2



Display in colour graphic / Option 3



5.6.2 MEASUREMENT OF SURFACE RECTANGLE / MEASUREMENT OF GUIDE WAYS

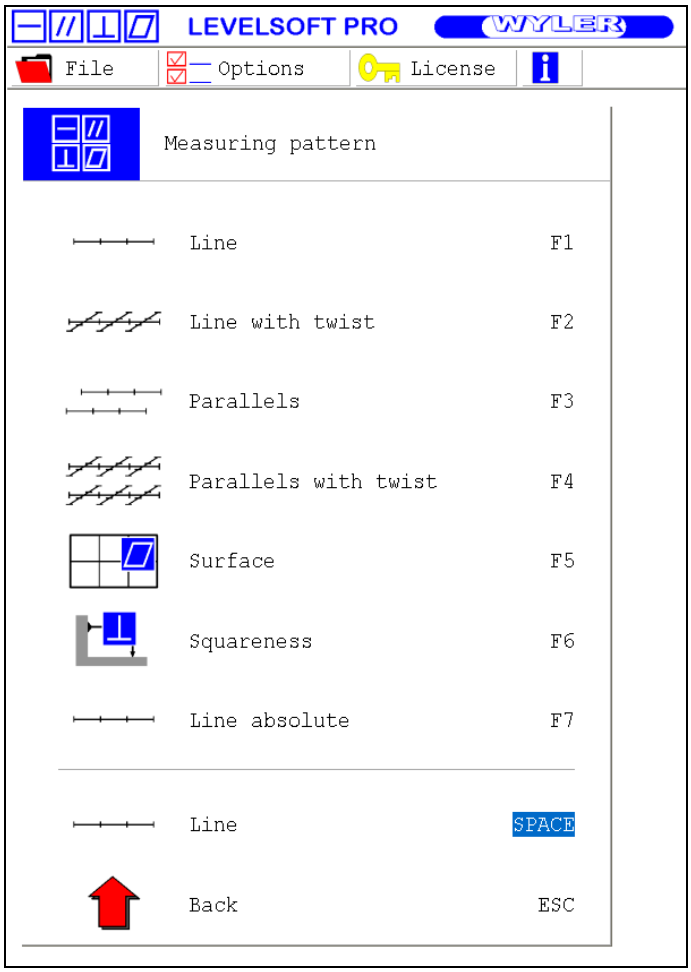
General remarks:
The procedure concerning preparation, setting parameters and measurement are identical to the measurement of a surface “WYLER Grid” described in chapter 5.6.1. The only but important difference lays in the different alignment method.
The measured object is aligned in a way that the two endpoints of the first longitudinal line and the two endpoints of the first transversal line are on the same level.

Example:
FLATNESS Measurement of a granite surface plate in the size of 550 x 300 mm / Differential measurement with two instruments

- Two instruments are connected to the PC via a Levelmeter2000
- Measuring object: RECTANGLE (grid pattern)
- Step length longitudinal: 125 mm
- Step length transversal: 125 mm
- No. of longitudinal lines: 3
- No. of transversal lines: 5
- Measuring density long / cross: 1
- Base length of the instruments: 150 mm

As mentioned the calculation of the layout and the input of the parameters are identical to the “WYLER Grid” described in chapter 5.6.1.

The measuring procedure and the description of the various parameters are similar to the measurement of a LINE up to the selection of the measuring object.



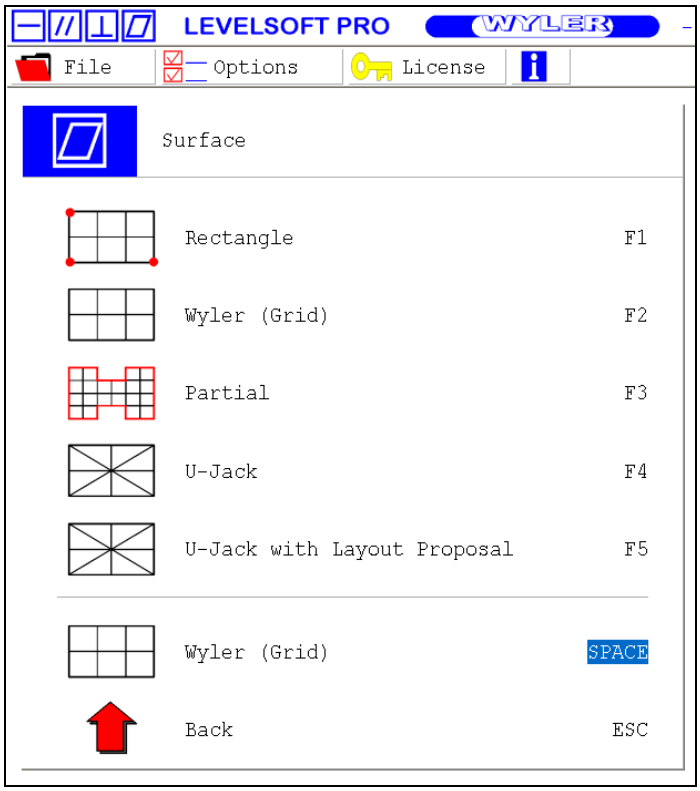
The following dialogue box is seen with the listing of the possibilities of the objects:

- **LINE**
  Measurement of lines
- **LINE WITH TWIST**
  Measurement of lines with twist
- **PARALLELS**
  Measurement of up to 3 parallels
- **PARALLELS WITH TWIST**
  Measurement of up to 3 parallels with twist
- **SURFACE (flatness)**
  Measurements of surfaces, respectively flatness:
  - surface
  - rectangle => alignment only according to "end points" in X- and Y-direction“
  - U-Jack => alignment specified by the standard / US-Governmental requirements GGG-P-463 c
  - U-Jack with **layout proposal** => alignment specified by the standard / US-Governmental requirements GGG-P-463 c
  - Partial => Measurement of partial surfaces based on the pattern "surface WYLER"
- **SQUARENESS** (Measurement of right angle) Measurement of 90 deg. Angles
- **LINE ABSOLUTE**
  Measurement of a line with absolute values

In our example chose now <SURFACE > / [F5]

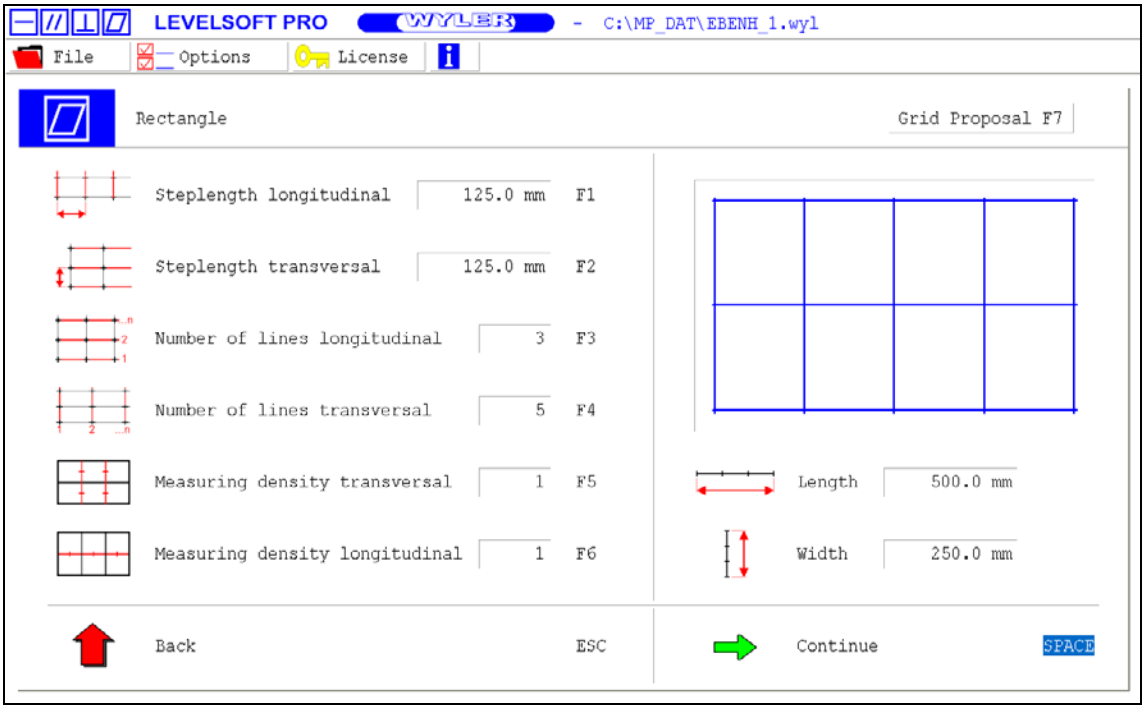
A number of three different options are available

- **Rectangle**
  The measured object is aligned in a way that the two endpoints of the first longitudinal line and the two endpoints of the first transversal line are on the same level.
- **Surface WYLER** / GRID
  Standard-measuring principle for flatness measurement with a grid
- **U-Jack** / US-Standard "GGG – P – 463 c"
  This method is mainly used in the US and in the UK. The mayor disadvantage compared with the “WYLER” method according to DIN 876 / Part 1, is the fact that the total surface of the object is not covered optimal.
- **Partial** / Partial surface based on the measuring object Surface WYLER"
  This object makes sense to chose, when some obstacles are in the surface (Cut out, etc.)



In our example chose now <Rectangle>[F1]

The mask for entering the parameters is displayed.



The following parameters must be entered now:

- Step length longitudinal 125mm
- Step length transversal: 125mm
- Number of measurements longitudinal: 3
- Number of measurements transversal: 5
- Measuring density longitudinal: 1
- Measuring density transversal: 1

The data is displayed in the monitor (top right) and can be accepted with <Continue> / [SPACE]

As an alternative the grid layout may be defined by using the “**Grid Proposal**". The procedure is described in detail in chapter 5.6.1. "Surface Grid (WYLER)" DIN 876 / Part 1 (Grid)”

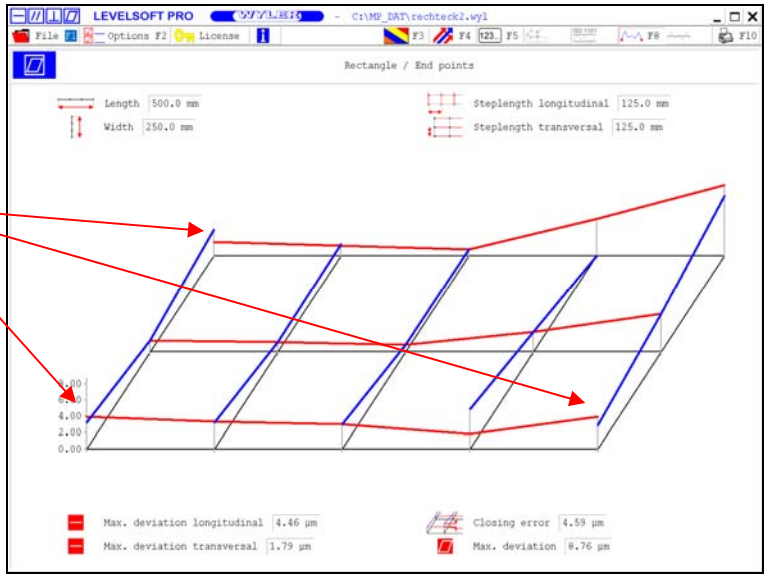
The other steps are identical to measuring a line:

- Way of measuring
- Limit of variation
- Surveillance of drift
- Start measurement, with/without saving the measuring pattern

is identical to measuring a line

Special in the measurement of the RECTANGLE is :

Points on the same height



In the title bar the measuring object is seen (RECTANGLE / ENDPOINTS. The maximum error is 2,4 µm, the closure error is 0,16 µm. The scale on the left hand side is displayed for better interpretation of the result.

The graphical display shows that the three most outer points are on the same height (First longitudinal line, first transversal line)

For the object "RECTANGLE"

- **no correction of the closure error by PHILIPS is possible**
- **only the alignment method "END POINTS" is possible**

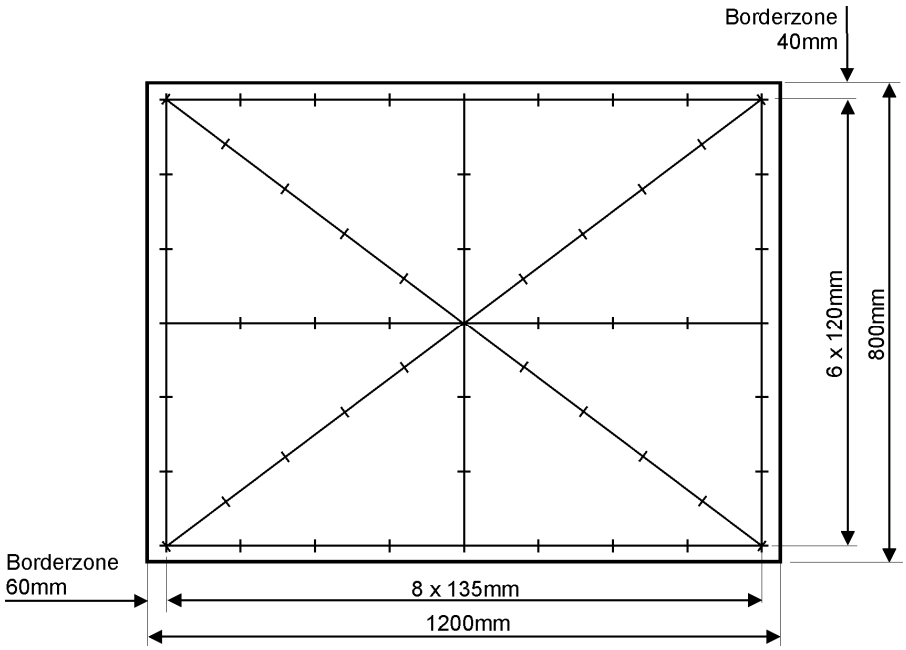
5.6.3 MEASUREMENT OF SURFACE USING THE METHOD "UNION - JACK"

5.6.3.1. Measurement of Surface method "US UNION - JACK" CONVENTIONAL METHOD MEANING ENTERING DATA MANUALLY

An additional method of measuring a surface is according to the so-called US-U-Jack principle. This method is mainly used in the US and in the UK. The mayor disadvantage compared with the “WYLER” method according to DIN 876 / Part 1, as described in chapter 5.6.1, is the fact that the total surface of the object is not covered optimally.

Example:
FLATNESS Measurement of a granite surface plate in the size of 1200 x 800 mm / Differential measurement with two instruments

- Two instruments are connected to the PC via a Levelmeter2000
- Surface: U-Jack
- Plate size longitudinal 1200 mm
- Plate size transversal 800 mm
- Border zone longitudinal 2 x 60 mm
- Border zone transversal 2 x 40 mm
- Step length longitudinal 120…145 mm (Possible range of base)
- Step length cross 120…145 mm (Possible range of base)
- Step length diagonal 120…145 mm (Possible range of base)
- Measuring density long / cross: according result
- Base length of the instruments: 150 mm
- (A possible layout could be as shown below)



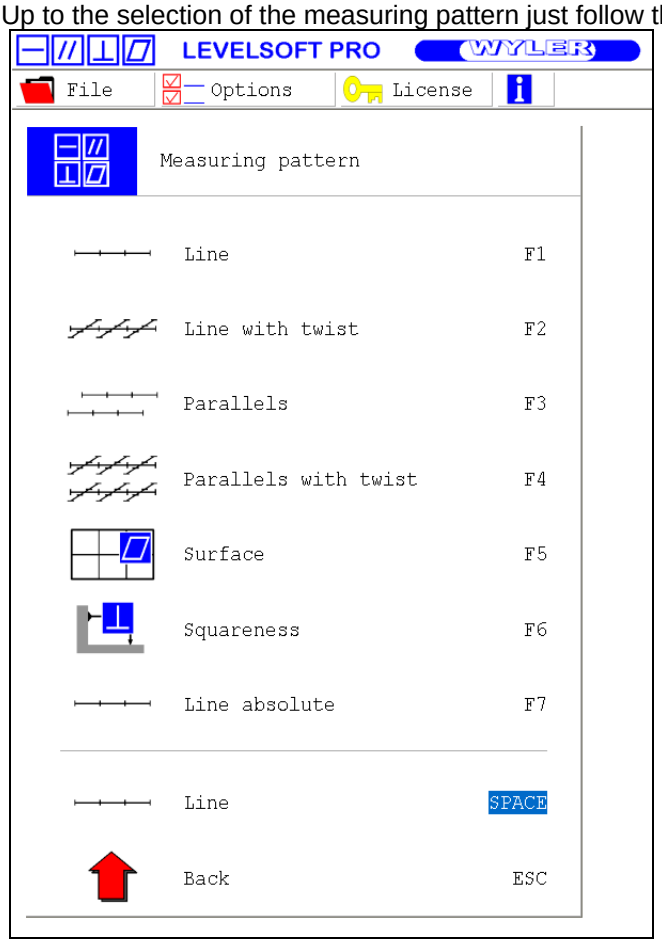
The layout must be so that:

- the step length is fitting to the base length
- the layout always follows the same pattern (as seen above) The number of steps as well as the step length can change.(The step length of the longitudinal, the transversal and the diagonal lines can be different)
- the three longitudinal and the three transversal lines must be symmetric. Therefore always an even number of steps are used.
- the US standard "**GGG – P – 463 c"** must be observed
- the layout connecting errors in the corners must be less than 8 mm, respectively 0.3 Inch.

Remarks:

- The instruments may be exchanged, e.g. due to the required size of the base length, during the measurement of the surface after the measurement of a set of lines.
- Please consult the US-standard "**GGG – P – 463 c"**
- In contrary to the measurement according to the "WYLER" method, DIN 876 / Part 1, when using the U-Jack every line is treated as an individual element

Up to the selection of the measuring pattern just follow the same procedure as when measuring a line



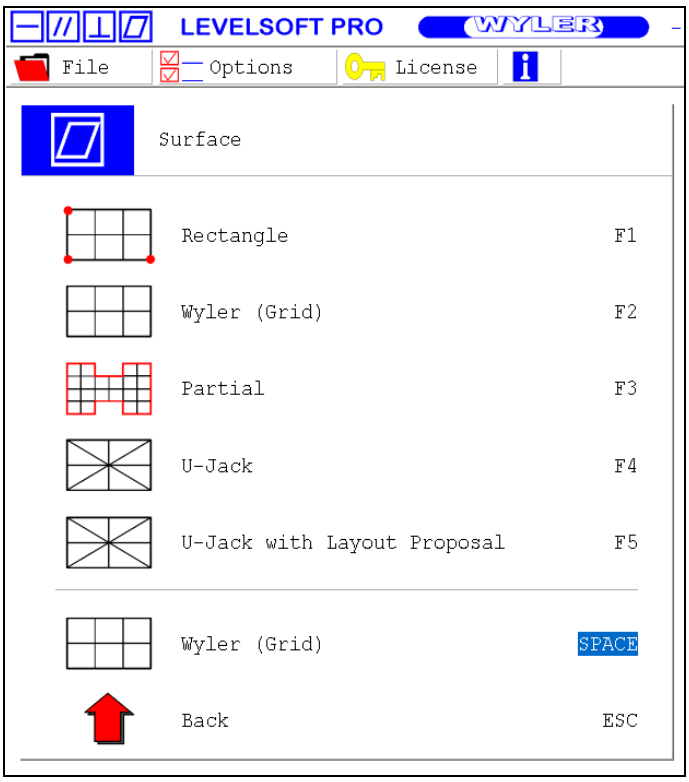
The following dialogue box is seen with the listing of the possibilities of the objects:

- **LINE**
  Measurement of lines
- **LINE WITH TWIST**
  Measurement of lines with twist
- **PARALLELS**
  Measurement of up to 3 parallels
- **PARALLELS WITH TWIST**
  Measurement of up to 3 parallels with twist
- **SURFACE (flatness)**
  Measurements of surfaces, respectively flatness:
  - surface
  - rectangle => alignment only according to "end points" in X- and Y-direction"
  - U-Jack => alignment specified by the standard / US-Governmental requirements GGG-P-463 c
  - U-Jack with **layout proposal** => alignment specified by the standard / US-Governmental requirements GGG-P-463 c
  - Partial => Measurement of partial surfaces based on the pattern "surface WYLER"
- **SQUARENESS** (Measurement of right angle)
  Measurement of 90 deg. Angles
- **LINE ABSOLUTE**
  Measurement of a line with absolute values

In our example chose now <SURFACE > / [F5]

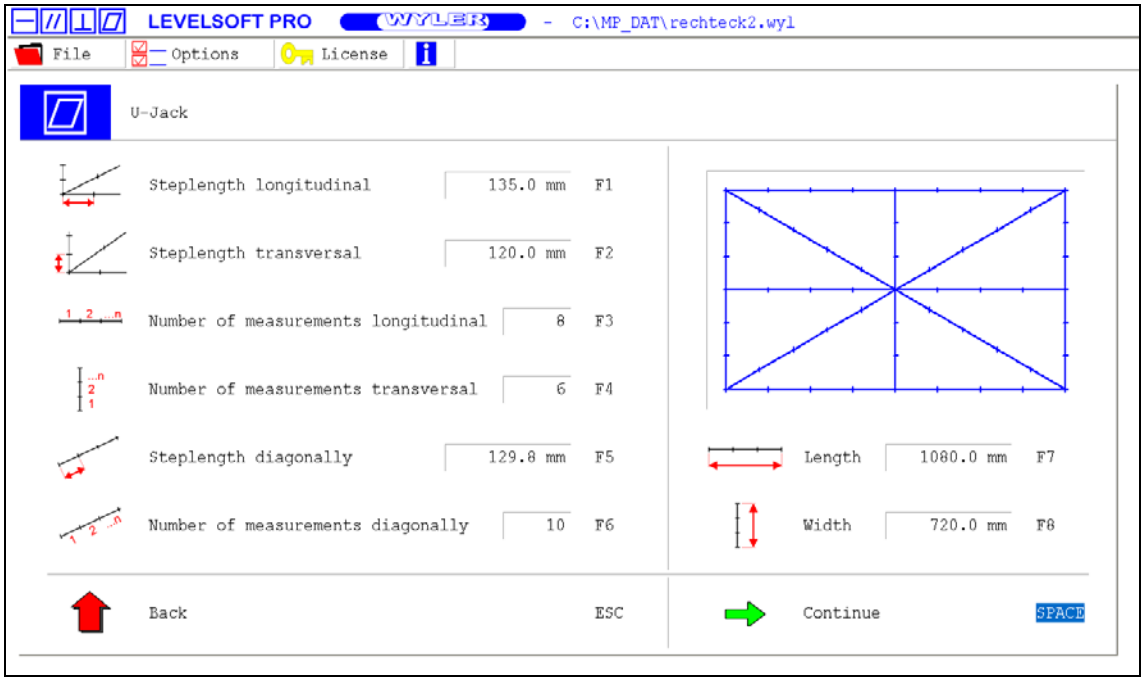
A number of five different options are available

- **Rectangle**
  The measured object is aligned in a way that the two endpoints of the first longitudinal line and the two endpoints of the first transversal line are on the same level.
- **Surface WYLER** / GRID
  Standard-measuring principle for flatness measurement with a grid
- **U-Jack** / US-Standard "GGG – P – 463 c"
  This method is mainly used in the US and in the UK. The mayor disadvantage compared with the "WYLER" method according to DIN 876 / Part 1, is the fact that the total surface of the object is not covered optimal.
- **U-Jack with Layout Proposal** US-Standard "GGG – P – 463 c"
  This method is mainly used in the US and in the UK. The mayor disadvantage compared with the "WYLER" method according to DIN 876 / Part 1, is the fact that the total surface of the object is not covered optimal.
  In this menu point a possibility exists to automatically compute a number of measuring proposals by entering the dimensions of the object to be measured as well as the available measuring instruments.
- **Partial**
  Partial surface based on the measuring object Surface WYLER"
  This object makes sense to chose, when some obstacles are in the surface (Cut out, etc.)



For our example we chose
<U-JACK> / [F4]

The mask for entering the parameters is displayed.



With first priority the division of the longitudinal lines and the transversal lines must be determined.
For longitudinal lines:
length = 1200 mm, minus 2 X border zone (2 x 60 mm) = 1080 mm, in order to enforce an even number of steps divide 1080 mm by 2 = 540 mm.
4 measuring steps of 135 mm = 540 mm. For the complete line = **8 measuring steps of 135 mm** each.
Use the same method to calculate the number and length of the measuring steps for the transversal lines
The result = 6 measuring steps of 120 mm each**.**
The values calculated must now be entered in the respective input field.
The software will provide a measuring layout (basic setting) without considering the possible step lengths for the available instruments in the diagonal lines. By changing the number of measurements diagonal you must now find a suitable solution. (Only an even number is permitted.) With 10 measuring steps you get a step length of 129.8 mm. For this step length the measuring base of 150 mm can be used.

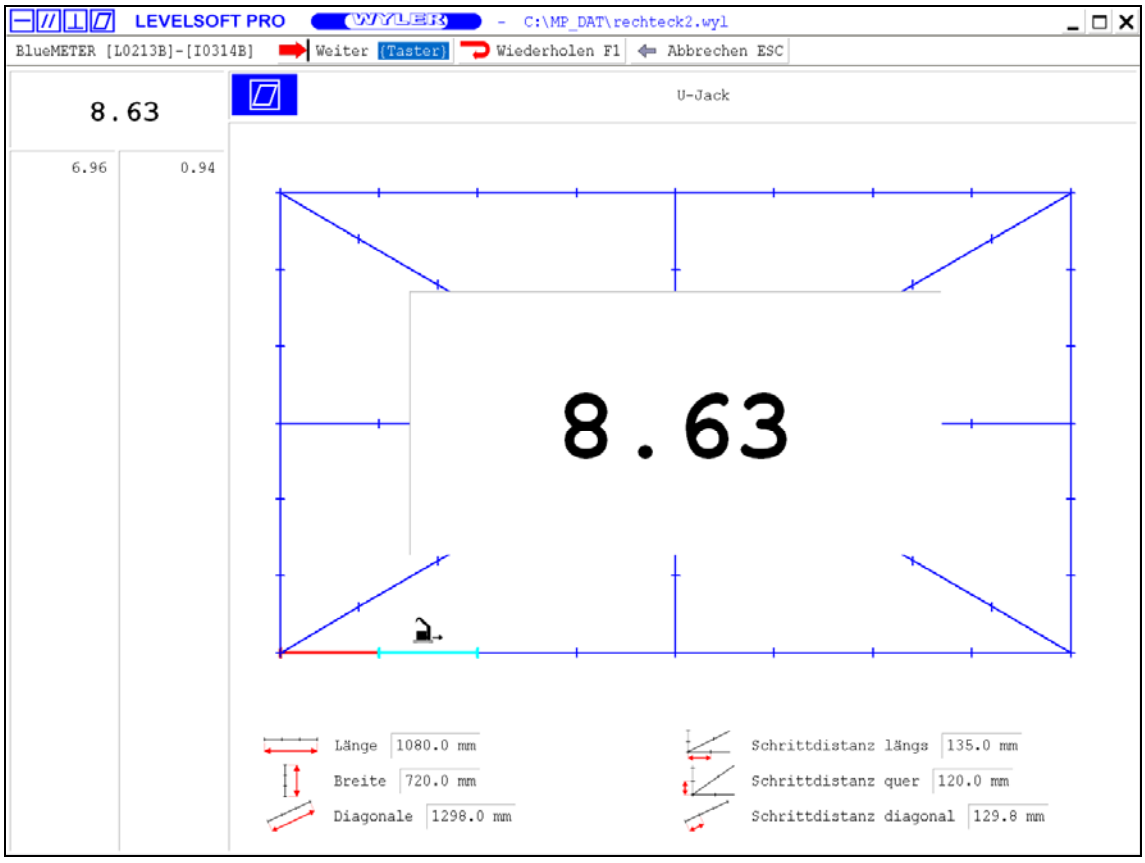
After selection the result is displayed in the monitor (top right) and can be used for checking the result. You can now <Continue> by using [SPACE]

The other steps

- Way of measuring
- Limit of variation
- Start measurement, with/without saving the measuring pattern

are identical to measuring a line.

The measurement can now start by using <Start measurement> / [F11] (without saving of the measuring pattern), or using [SPACE] for <Save and start measurement>

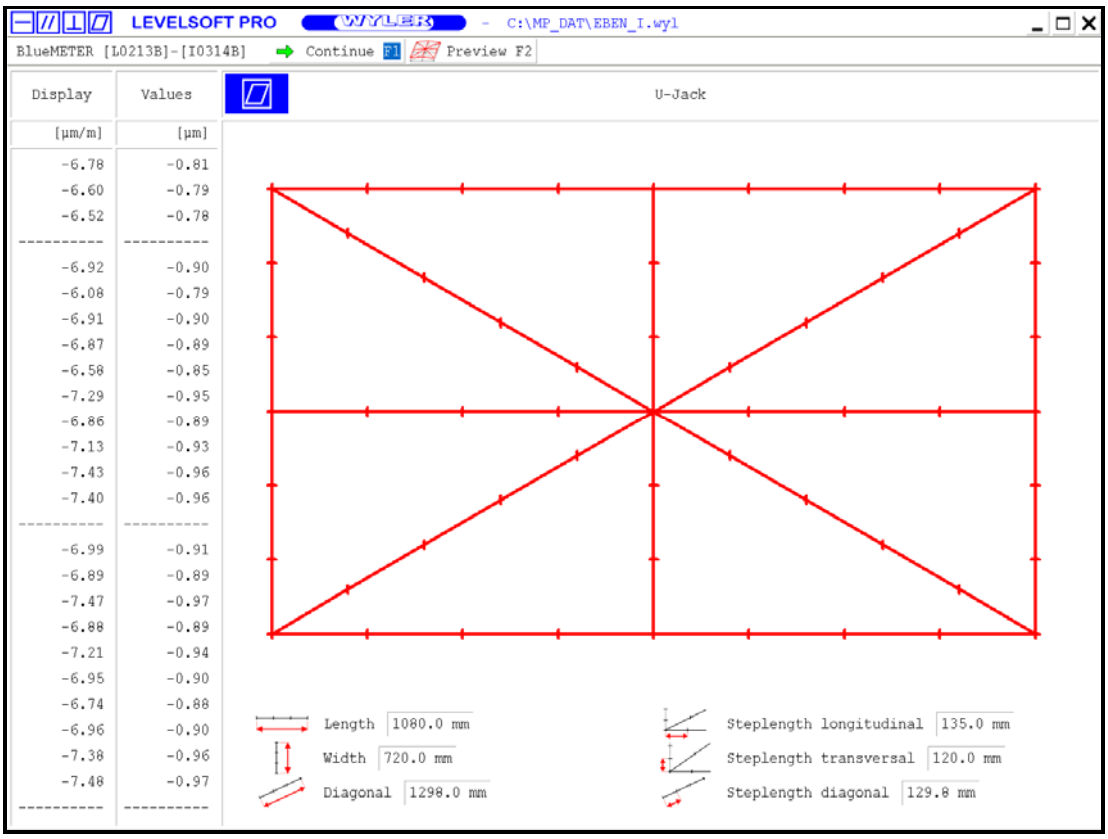


After successful collecting of the measurement data the value will be displayed on the screen for checking in large letters. When continuing with the confirmation of the value the displayed figures disappear.

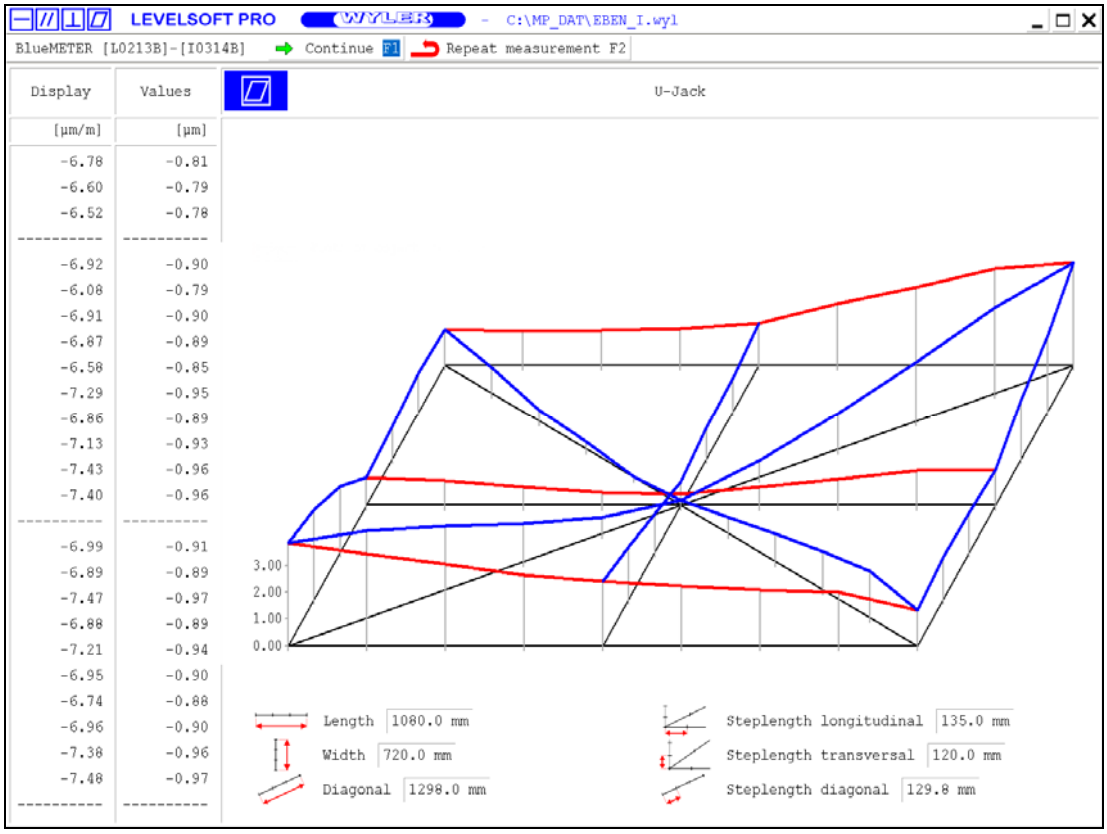
Repeat measurement:

- After the actual collecting of the measured the measurement can be repeated by using <REPEAT> / [F1]
- After confirming the latest individual measuring value it is possible to use <BACK> / [F2] and then all the values of the whole last measured line can be measured again.

After the last measuring step the following screen will appear. With the icon <Pre-view> / [F2] the measured pattern can be viewed without completing the measurement definitely.

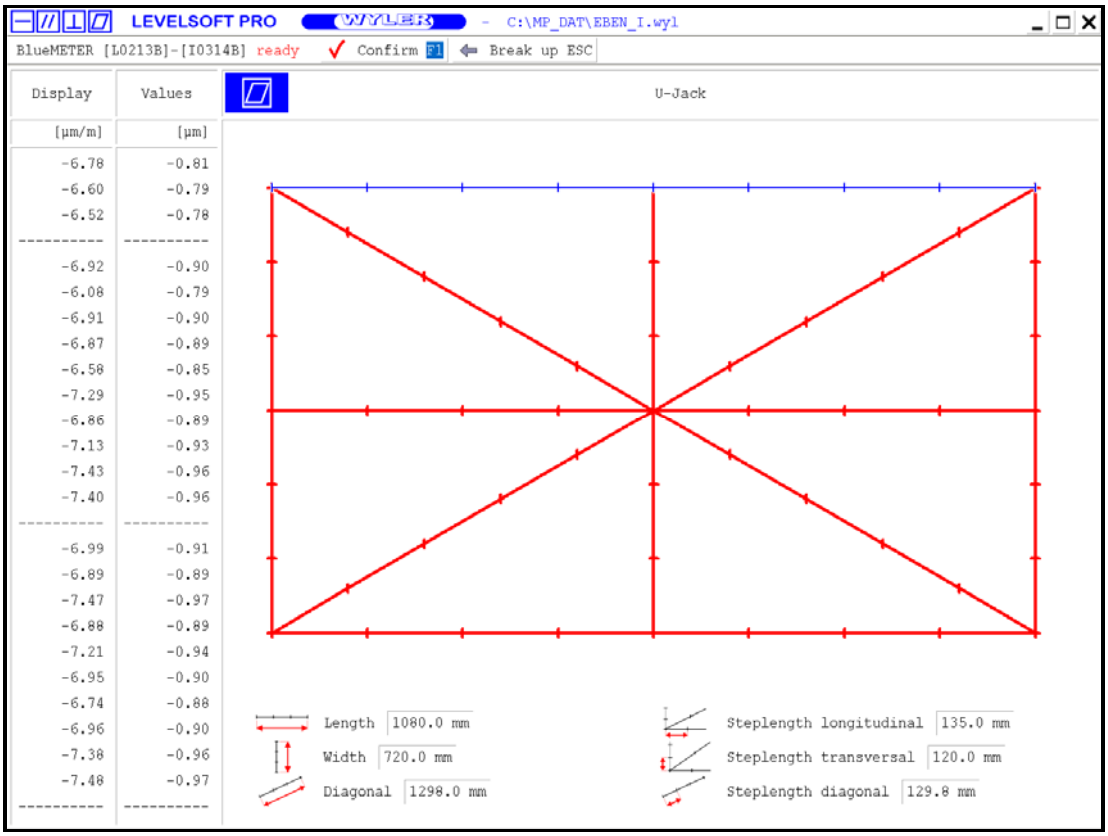


Based on this pre-view the user can decide to **repeat the measurement of one of more lines**.

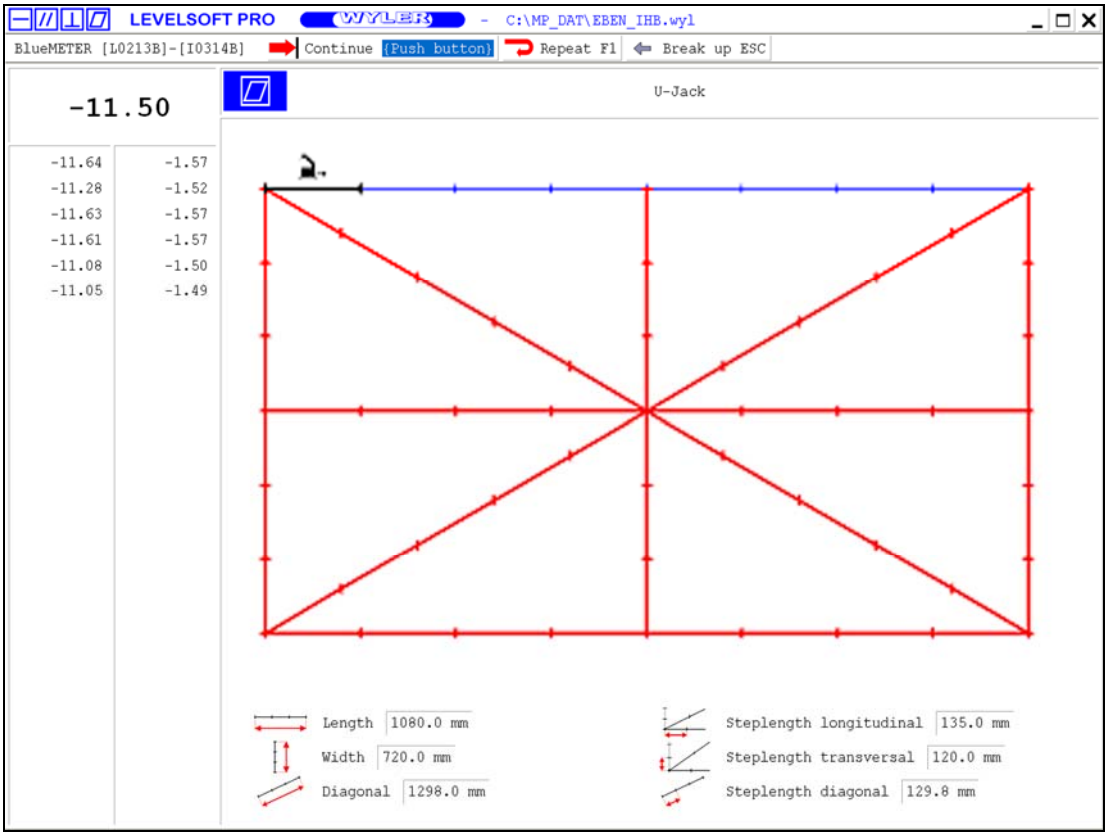


In order to do so, use the key <Repeat Measurement> / [F2].

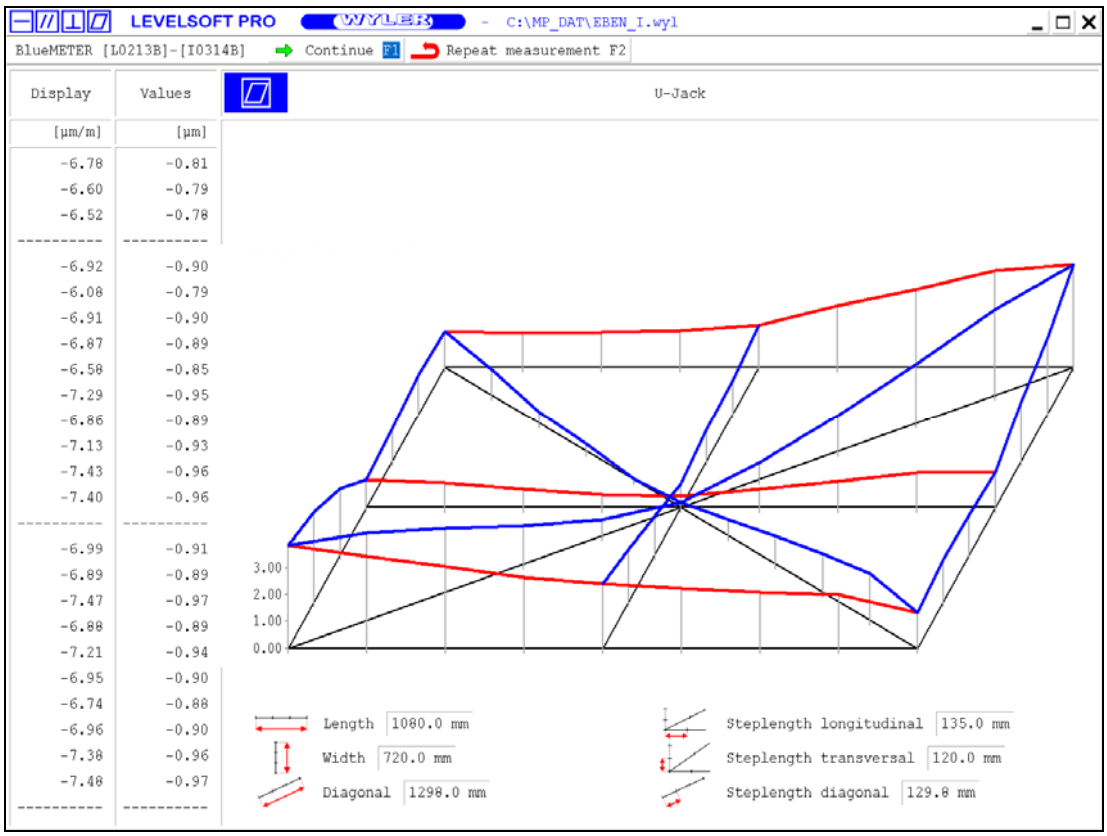
Click with the mouse on the line, resp. lines, you intend to measure again and confirm your selection with <Confirm> / [F1]. In our example we will repeat the measurement of the third longitudinal line.

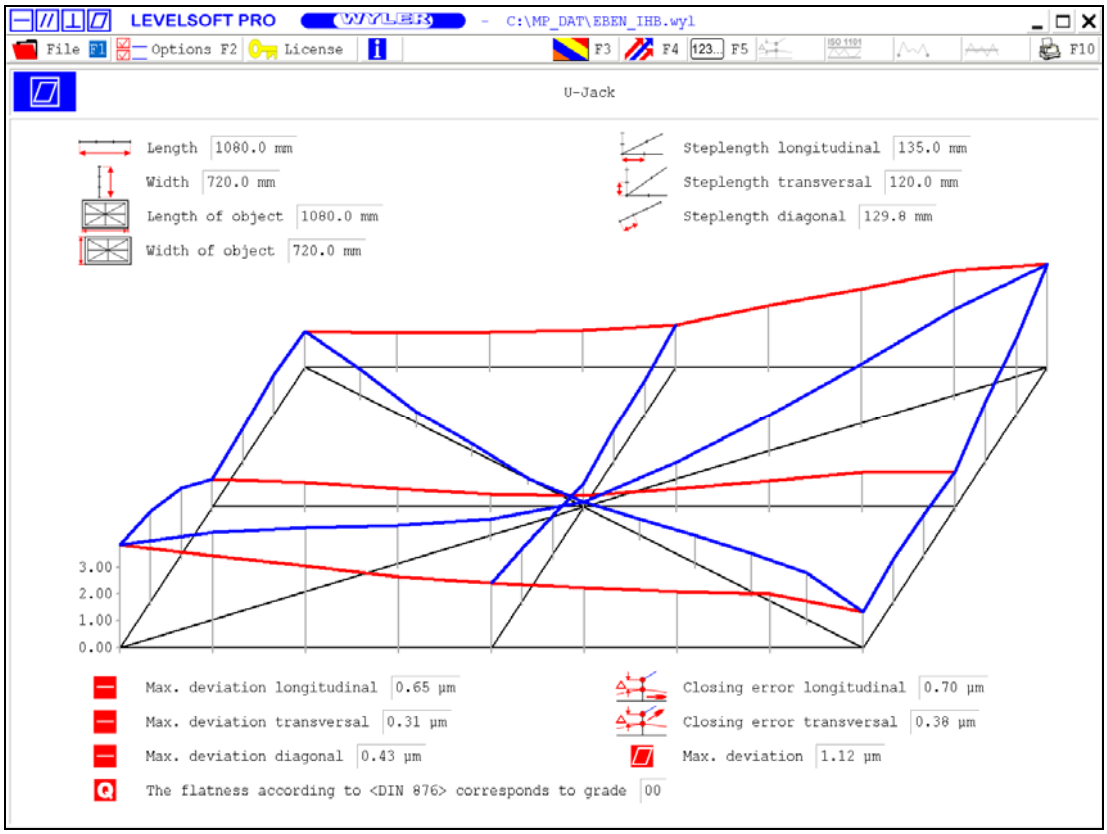


The respective line can now be measured again. After completing the measurement the menu <Pre-view> / [F2] will allow again to repeat the measurement of one or more lines.



If the measurement corresponds to the target it can be definitely finished with <CONTINUE> / [F1] (see picture)





The maximum **Flatness Error** is 1.12µm,
the closure error longitudinal is 0,70µm and the closure error transversal is 0,38µm

The quality of the flatness according to DIN 876 is **Quality "00"**. Using the <Options> / [F2], <Change flatness standard> / [F7] another standard can be selected or the display of the standard may be deactivated. Additional information to the Quality standards is available in chapter 4.7.17 "Changing of flatness standards“.

Closure error

- "Closure error longitudinal" is the closure error between the longitudinal line and the diagonal line.
- "Closure error transversal" is the closure error between the transversal line and the diagonal line.
- The "Maximum error longitudinal/transversal/diagonal" is the maximum straightness error of the different lines.

Remarks concerning the closure errors:
The closure error is an important indication on the quality of the measurement.

The other steps are identical to measuring a line:

- Display in colour [F3]
- Switch between graphical display and measuring pattern [F4]
- Display measured values [F5]
- Printing

5.6.3.2. Measurement of Surface method "US UNION - JACK" USING THE LAYOUT PROPOSAL

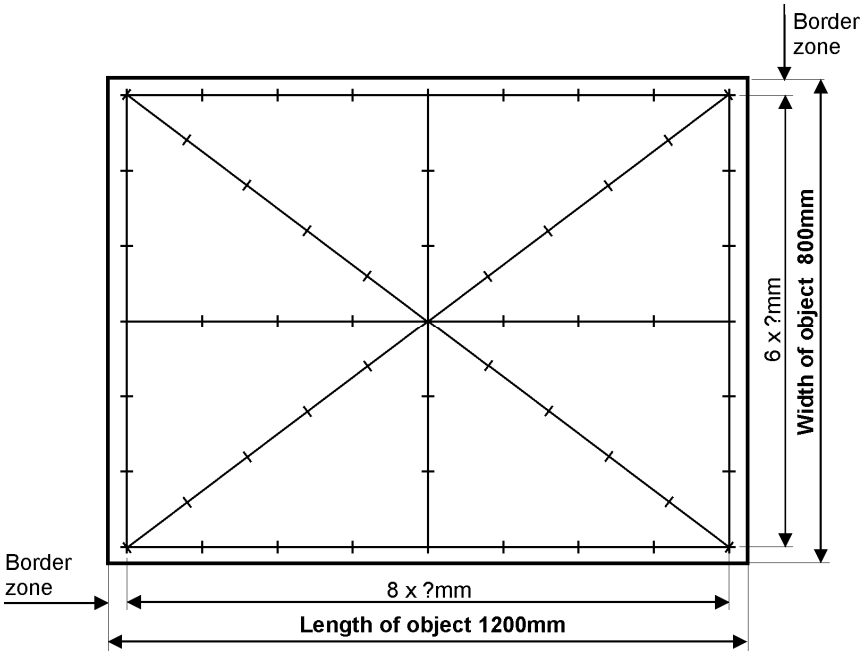
When using the U-Jack method with the layout proposal the software LEVELSOFT PRO will generate a number of possibilities taking the existing instruments and the size of the measured object into account. The best suitable proposal can be accepted by the user.

Example:
FLATNESS Measurement of a granite surface plate in the size of 1200 x 800 mm / Differential measurement with two instruments

- Two instruments are connected to the PC via a Levelmeter2000
- Surface: U-Jack
- Plate size longitudinal 1200 mm
- Plate size transversal 800 mm

- **Option A**
  WYLER Base
  150 mm / 120....145mm (possible step length variation of the base)

- **Option B**
  WYLER Flexbase 250mm
  100mm ... 240mm (possible step length variation of the base)
  70mm … 270mm (extended range)



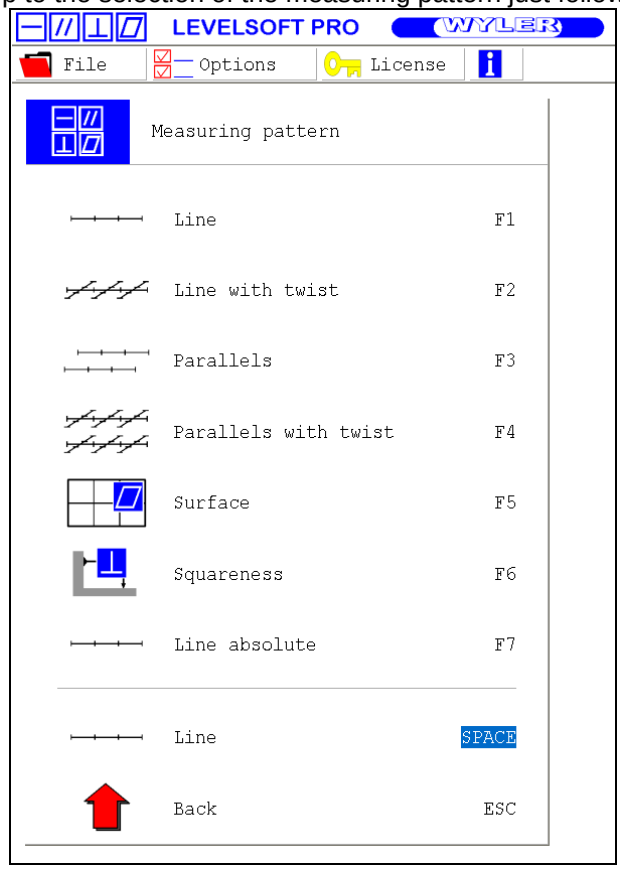
The U-Jack pattern must be laid out so that

- the step length is corresponding with the available base of the measuring instrument
- the layout is done always according to the same pattern (see above) The number of steps and the length of the steps can vary, the step length of the longitudinal, the transversal and the diagonal lines can be different
- the three longitudinal and the three transversal lines must be symmetrical this means that always an even number of steps is used
- the US-standard "**GGG – P – 463 c"** is applied
  - one line must have at least 6 steps
  - the step length should not be bigger than 12“ (300 mm)
  - every line has an even number of steps
  - the connecting area at the crossing of the individual lines must not be larger than within a diameter of 0.3” (8mm)
  - Border zone
    - For diagonal line length between 12 and 48“ the maximum allowable border zone is 1“ (25.4 mm)
    - For diagonal line larger than 48“ (1219.2 mm) the maximum allowable border zone is 1.5“ (38.1 mm)

Remarks:

- Please consult the US standard "**GGG – P – 463 c**“
- In contrary to the measurement according to the WYLER” method, DIN 876 / Part 1, when using the U-Jack every line is treated as an individual element. (No information about parallelism is included)

Up to the selection of the measuring pattern just follow the same procedure as when measuring a line.



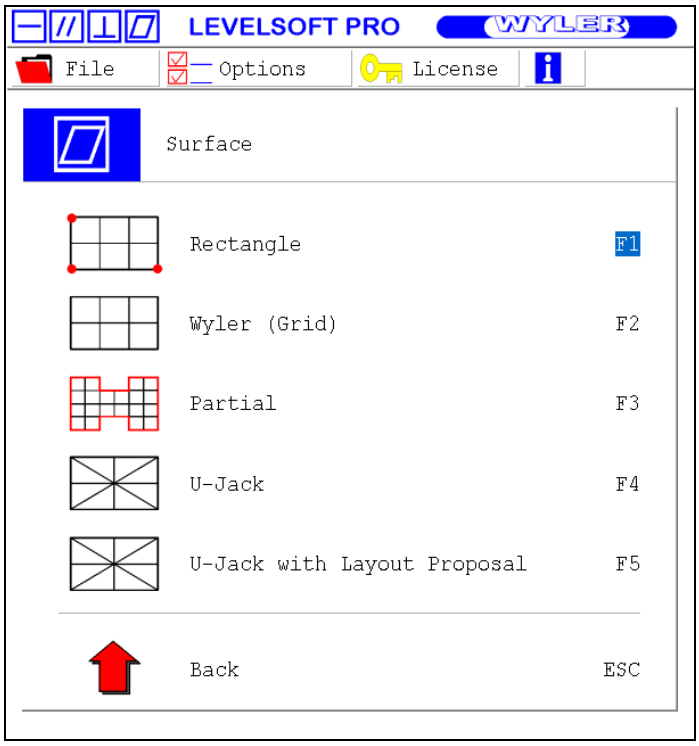
The following dialogue box is seen with the listing of the possibilities of the objects:

- **LINE**
  Measurement of lines
- **LINE WITH TWIST**
  Measurement of lines with twist
- **PARALLELS**
  Measurement of up to 3 parallels
- **PARALLELS WITH TWIST**
  Measurement of up to 3 parallels with twist
- **SURFACE (flatness)**
  Measurements of surfaces, respectively flatness:
  - surface
  - rectangle => alignment only according to "end points" in X- and Y-direction“
  - U-Jack => alignment specified by the standard / US-Governmental requirements GGG-P-463 c
  - U-Jack with **layout proposal** => alignment specified by the standard / US-Governmental requirements GGG-P-463 c
  - Partial => Measurement of partial surfaces based on the pattern "surface WYLER"
- **SQUARENESS** (Measurement of right angle)
  Measurement of 90 deg. Angles
- **LINE ABSOLUTE**
  Measurement of a line with absolute values

In our example chose now <SURFACE > / [F5]

A number of four different options are available

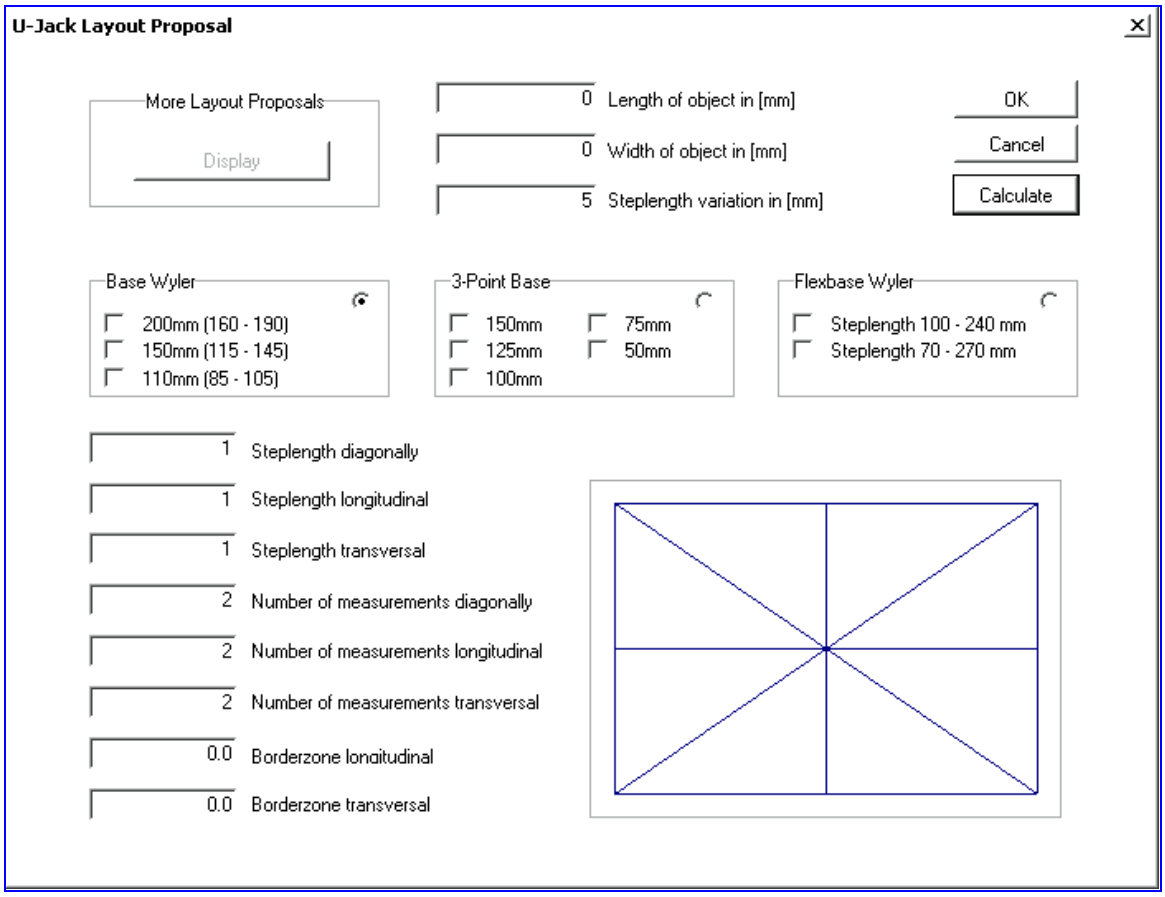
- **Rectangle**
  The measured object is aligned in a way that the two endpoints of the first longitudinal line and the two endpoints of the first transversal line are on the same level.
- **Surface WYLER** / GRID
  Standard-measuring principle for flatness measurement with a grid
- **U-Jack** / US-Standard "GGG – P – 463 c"
  This method is mainly used in the US and in the UK. The mayor disadvantage compared with the “WYLER” method according to DIN 876 / Part 1, is the fact that the total surface of the object is not covered optimally
- **U-Jack** with **layout proposal** / US-Standard "GGG – P – 463 c"
  This method is mainly used in the US and in the UK. The mayor disadvantage compared with the “WYLER” method according to DIN 876 / Part 1, is the fact that the total surface of the object is not covered optimally. In this menu it is possible to enter the instruments available as well as the size of the object to be measured and get some proposal for the layout.
- **Partial**
  Partial surface based on the measuring object Surface WYLER"
  This object makes sense to chose, when some obstacles are in the surface (Cut out, etc.)



In our example chose now
<U-JACK with layout proposal> / [F5

Option A: **WYLER-Base 150mm**
150 mm / 120....145mm (possible step length variation of the base)

The sub window "U-Jack Layout Proposal" for the parameters appears



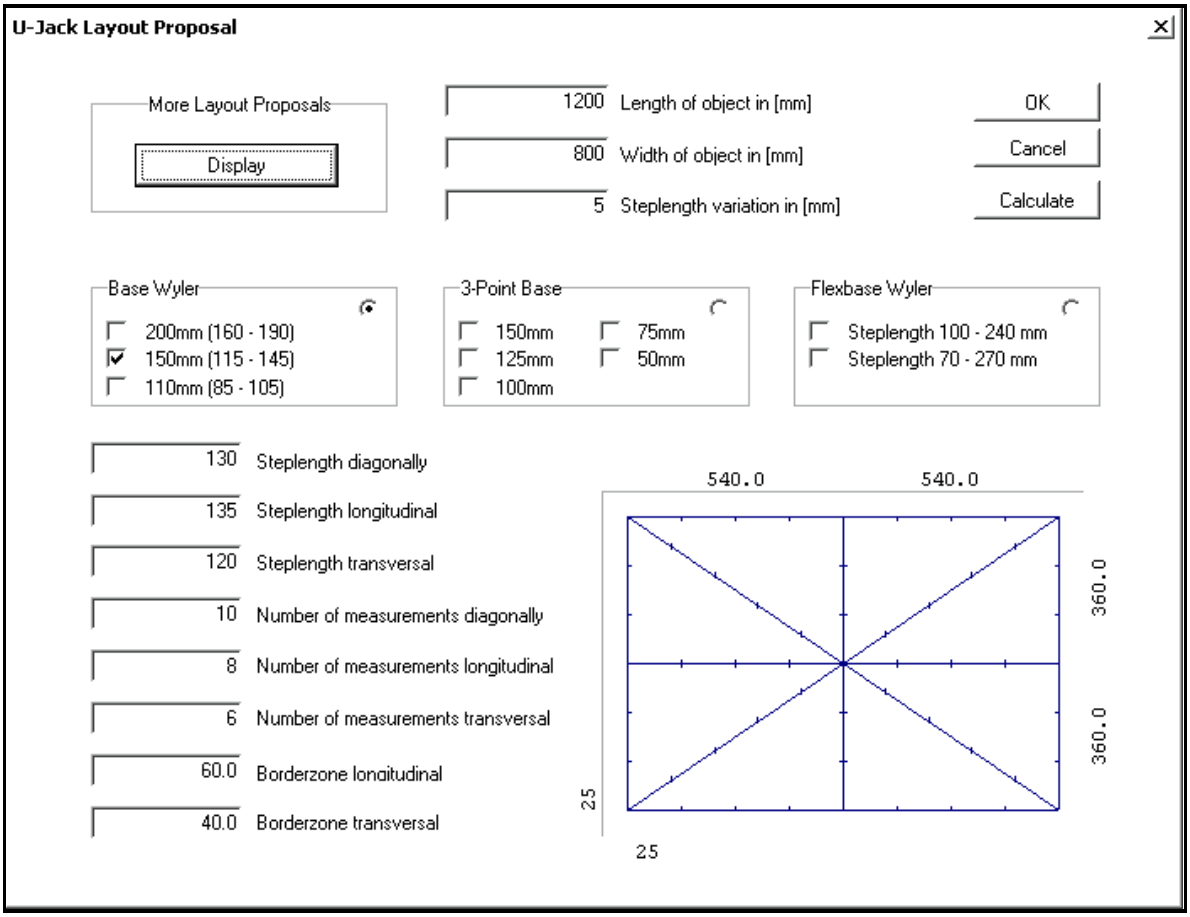
The length and the width of the object can be entered

- Length of object: 1200mm (Plate length)
- Width of object: 800mm (Plate width)
- WYLER base length: 150mm (115 … 145mm)

Procedure for data entering:

1. Entering the base length of the instrument used for longitudinal resp. transversal measurement
   a. Base WYLER: 150mm (115 … 145mm)
2. Entering the length and the width of the object
   a. Length of object: 1200mm (Plate length)
   b. Width of object: 800mm (Plate width)
3. With <Calculate>a first proposal will be generated

The software is now calculating a first series of possibilities using the base length set (In our example WYLER base 150 mm)



The data will be displayed in the monitor lower left side and can be used for a check

In a first step the following parameters will be computed

- Step length diagonally: 130mm
- Step length longitudinal: 135mm
- Step length transversal: 120mm
- Number of measurements diagonally: 10 total
- Number of measurements longitudinal: 8 total
- Number of measurements transversal: 6 total
- Border zone longitudinal: 60mm
- Border zone transversal: 40mm

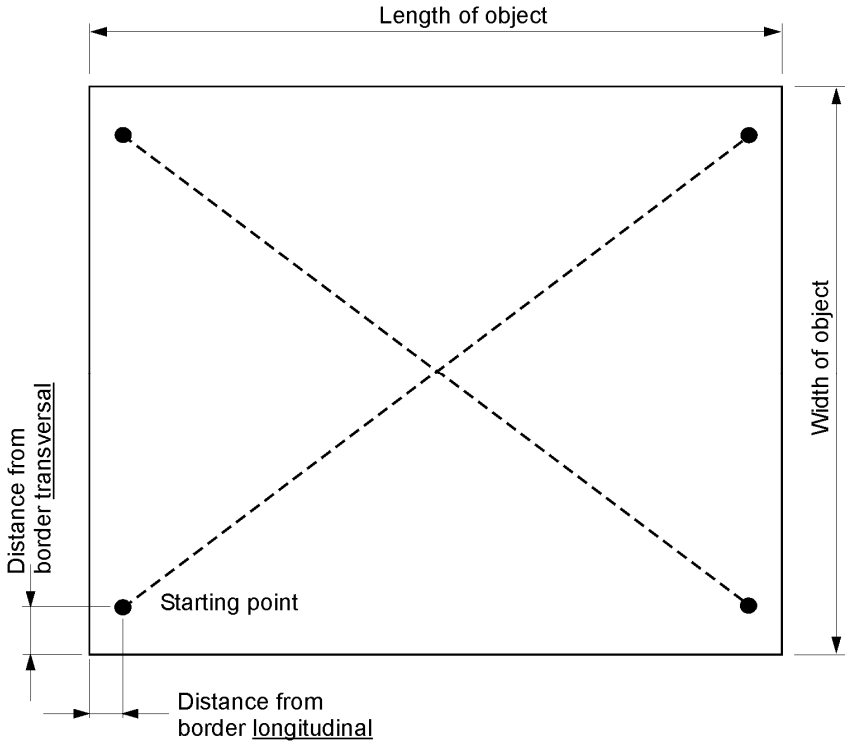
In addition the following information is displayed in the monitor

- Half length of the longitudinal lines 4x135mm = 540mm
- Half length of the transversal lines 3x120mm = 360mm
- Distance of beginning and end point of the diagonal
    - Distance from border longitudinal 25mm
    - Distance from border transversal: 25mm

The beginning and endpoint of the diagonal is not in every case on exactly the same spot as the longitudinal respectively the transversal lines are. According to the specification the crossing points must lay within an area with a diameter of 8 mm respectively 0.3”. The graphic below gives additional information to this.

Drawing the layout:

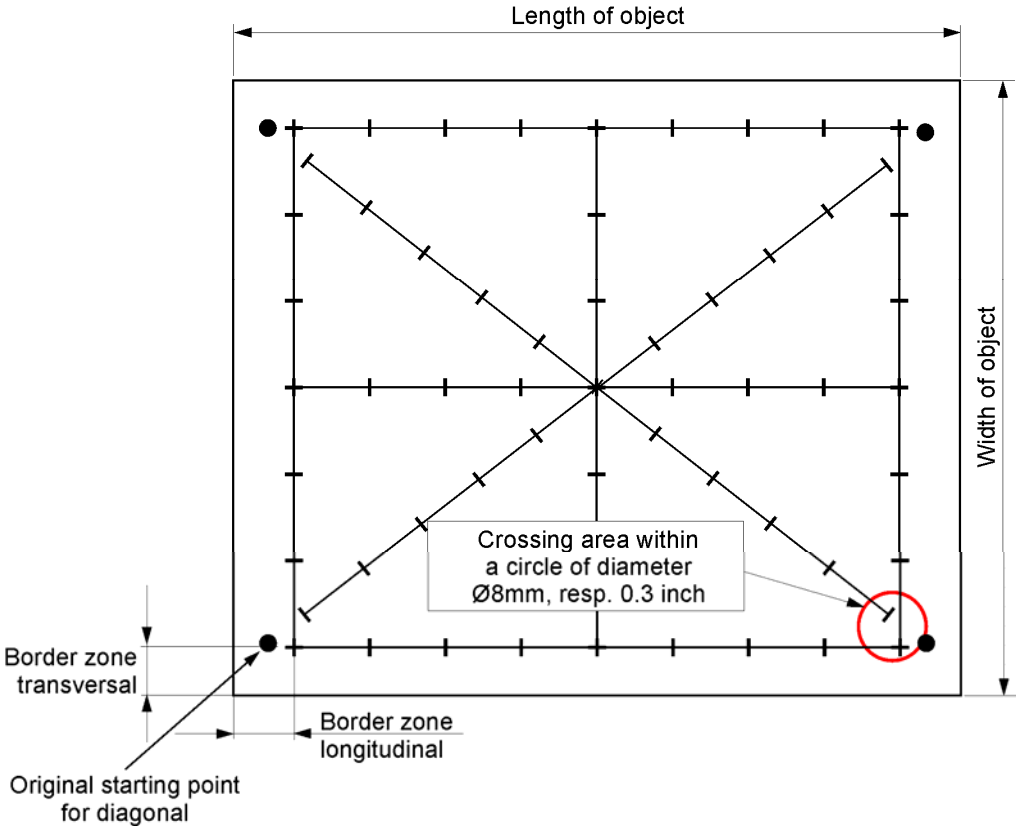
1. Step Drawing of the diagonals (starting at 25 mm transversal / 25 mm longitudinal)



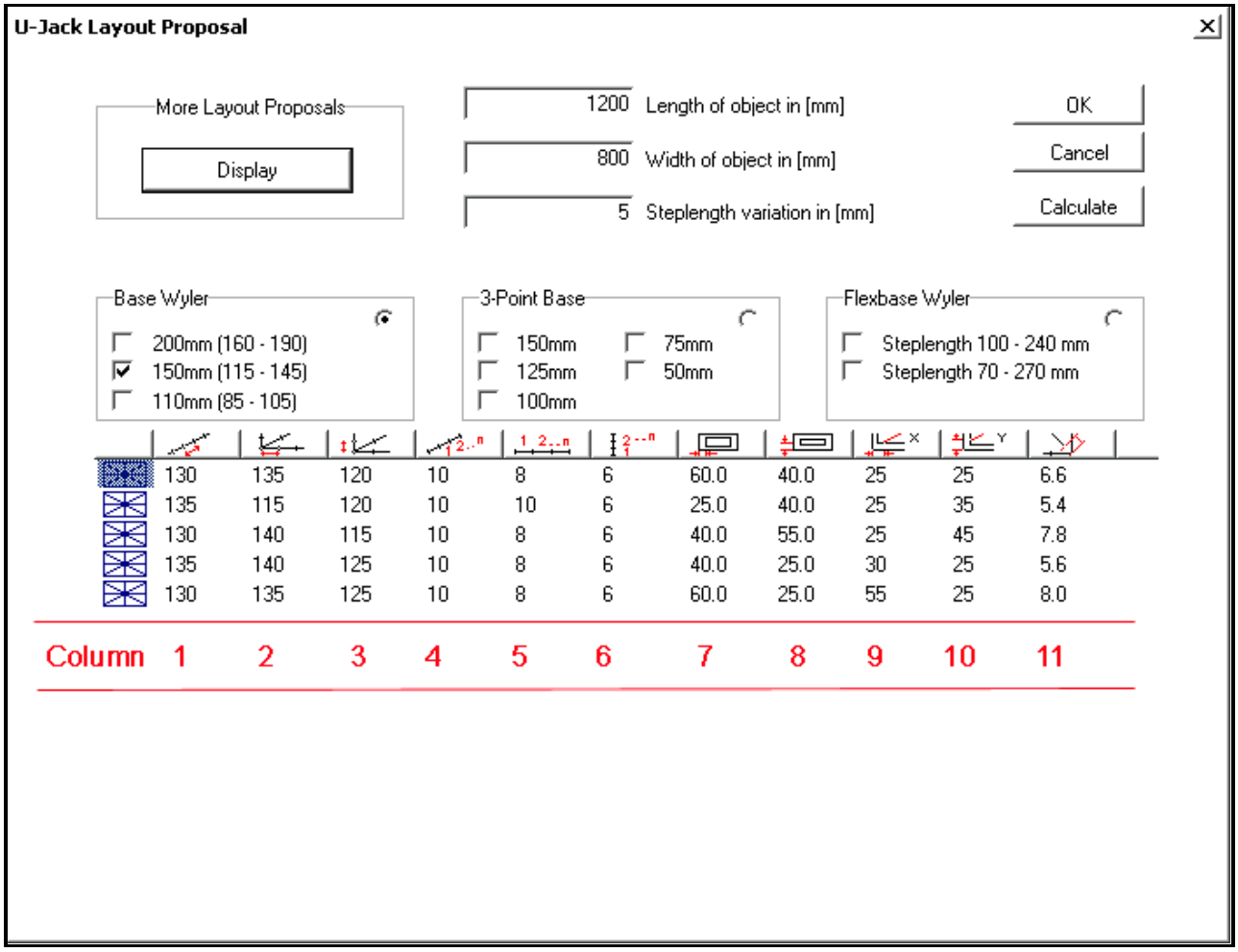
2. Step:

- Drawing the definite diagonals with the step length of 130 mm

Drawing of the longitudinal and transversal lines starting at the centre by applying the correct border zone (starting at 25 mm transversal / 25 mm longitudinal) and step length. The longitudinal and the transversal lines are always meeting at the same spot.



In case the initial proposal is not meeting the requirements the possibility exists for displaying additional proposals. Press the key <Display> in the field "More Layout Proposals"



A number of additional proposal appear in list form whereas the following explanation is given for understanding the details:

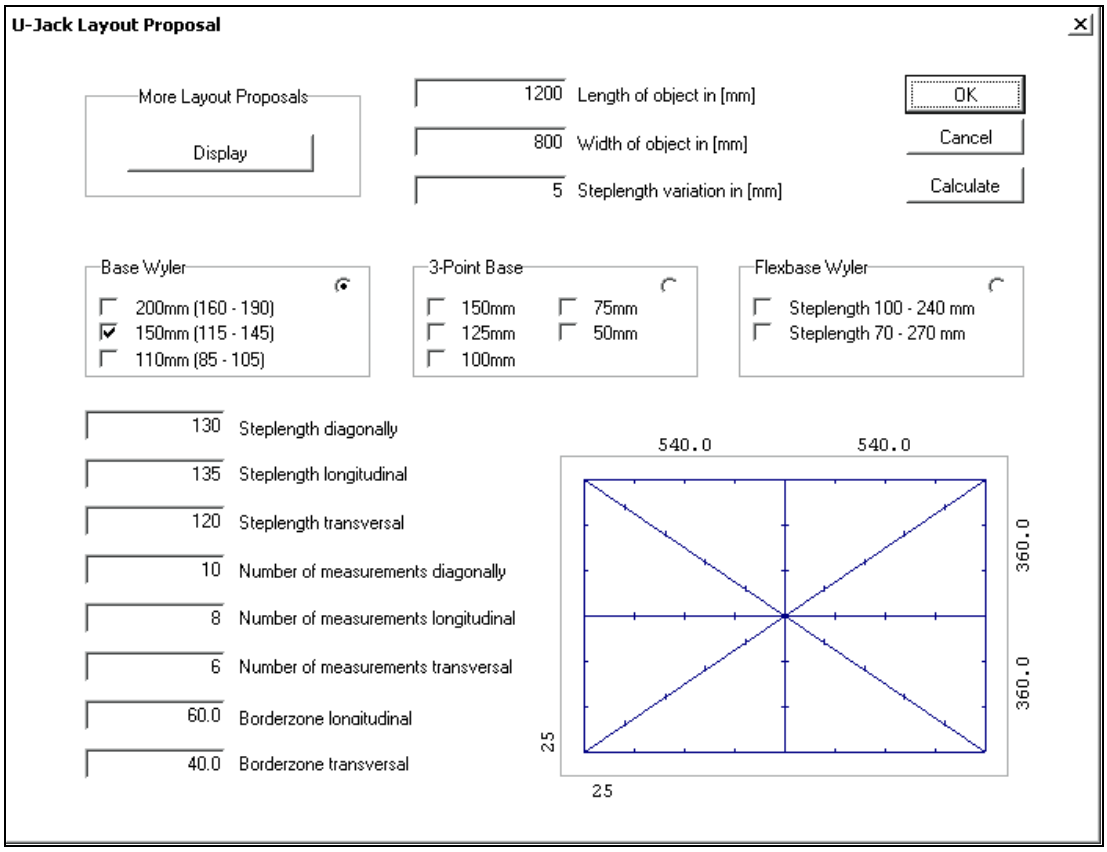
- Column 1 … 3: Step length diagonal, longitudinal and transversal
- Column 4 … 6: Number of steps diagonal, longitudinal and transversal
- Column 7 + 8: Border zone longitudinal, transversal
- Column 9 +10: Beginning and endpoint of diagonal (distance from borders)
- Column 11: Distance of the crossing point of the longitudinal and the transversal lines to the diagonal endpoint

The individual columns can be sorted according to different criteria by clicking to the respective icons of the columns. The original setting is achieved by clicking to the free space in the upper left corner.

The chosen proposal is now selected by **double click to the U-Jack** symbol.

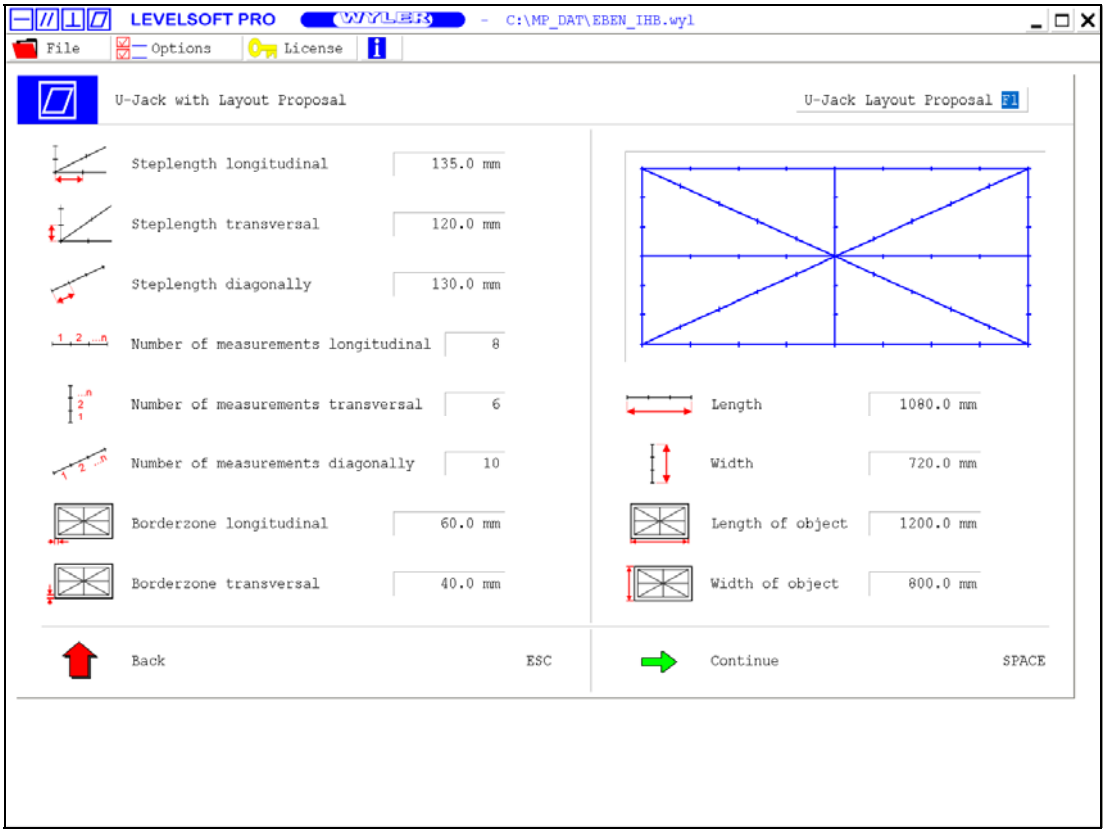
In our example we continue with the previously defined data!!!

The selected option will be integrated and displayed in the window for further actions

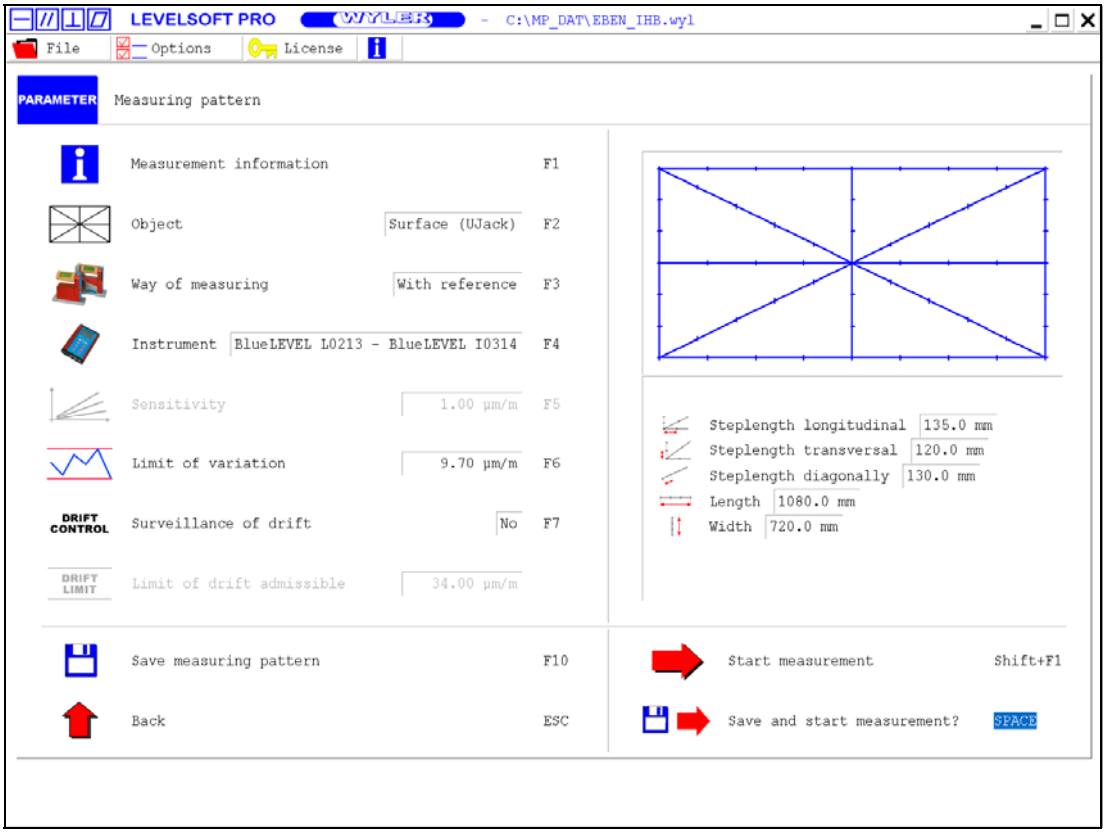


The parameters can now be checked again and then confirmed with <OK>. For additional proposals the function key <Display> can be applied from new and any other proposal may be selected.

After confirming with <OK> the complete pattern with the parameters is displayed.



Using <Continue> / [SPACE] the measuring procedure is ready for starting with the measurement of the object.

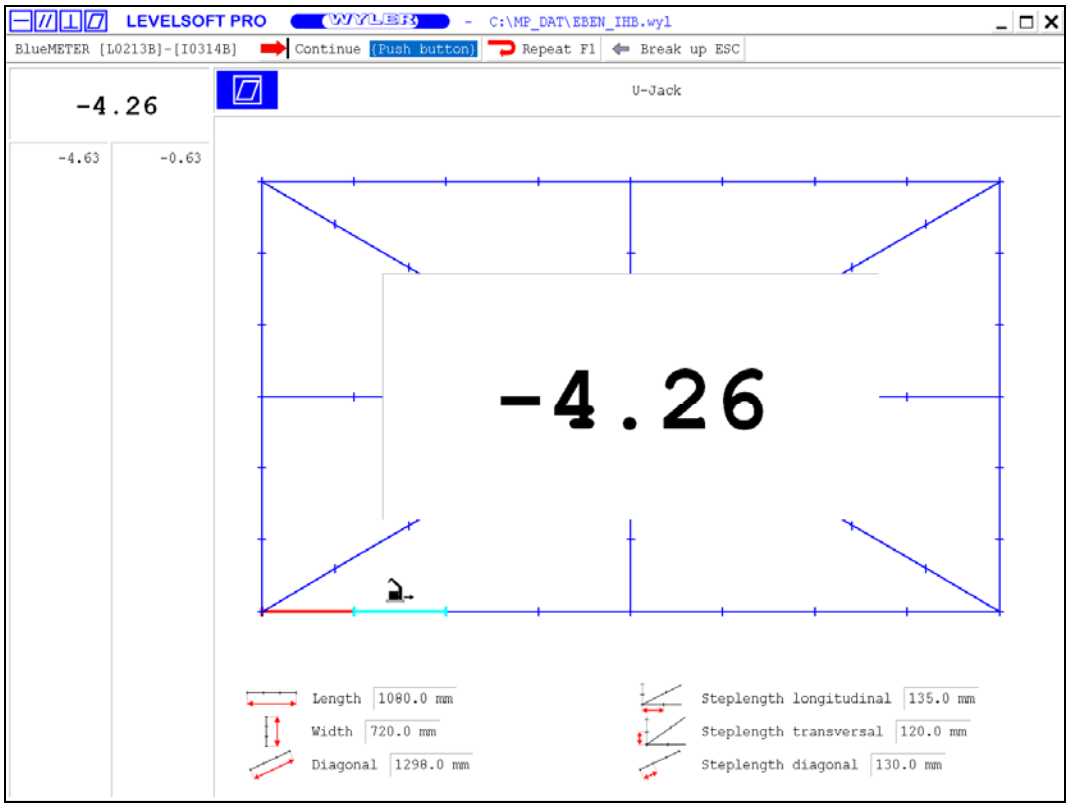


The other steps

- Way of measuring
- Limit of variation
- Surveillance of drift
- Starting the measurement with /without saving of the measuring pattern

are identical to measuring a line

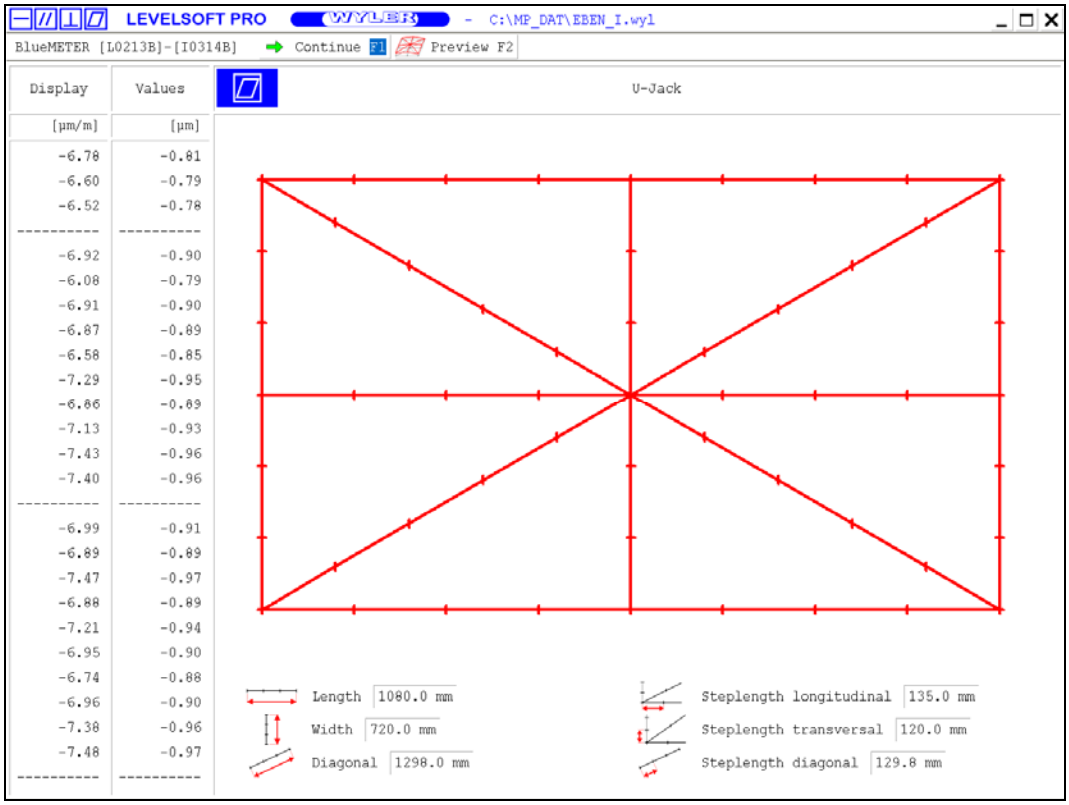
The measurement can now start by using <Start measurement> / [F11] (without saving of the measuring pattern), or using [SPACE] for <Save and start measurement>



After successful collecting of the measurement data the value will be displayed on the screen for checking in large letters. When continuing with the confirmation of the value the displayed figures disappear.

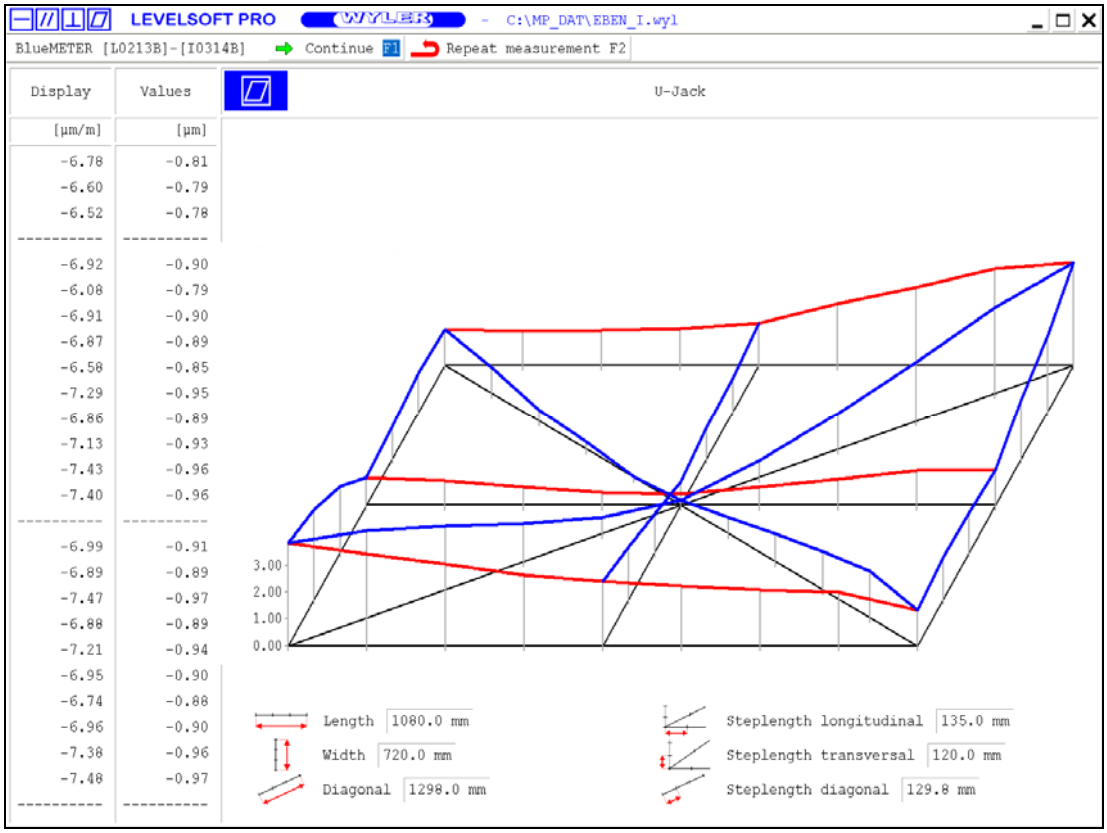
Repeat measurement:

- After collecting the actual measuring value the measurement can be repeated by using <REPEAT> / [F1]
- After confirming the latest individual measuring value it is possible to use <BACK> / [F2] and then all the values of the whole last measured line can be measured again.

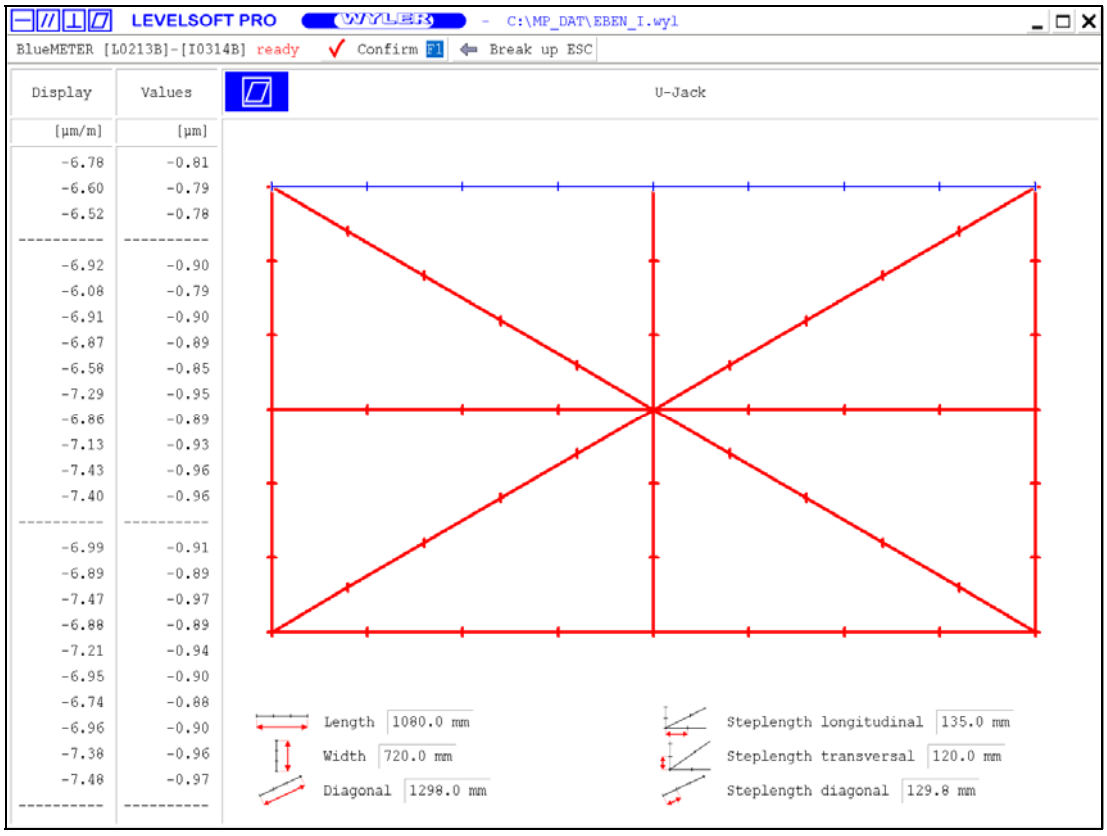


The above display is seen after the last measurement. Using the icon <Preview> / [F2] the measured object can be checked before finishing the measuring task definitely.

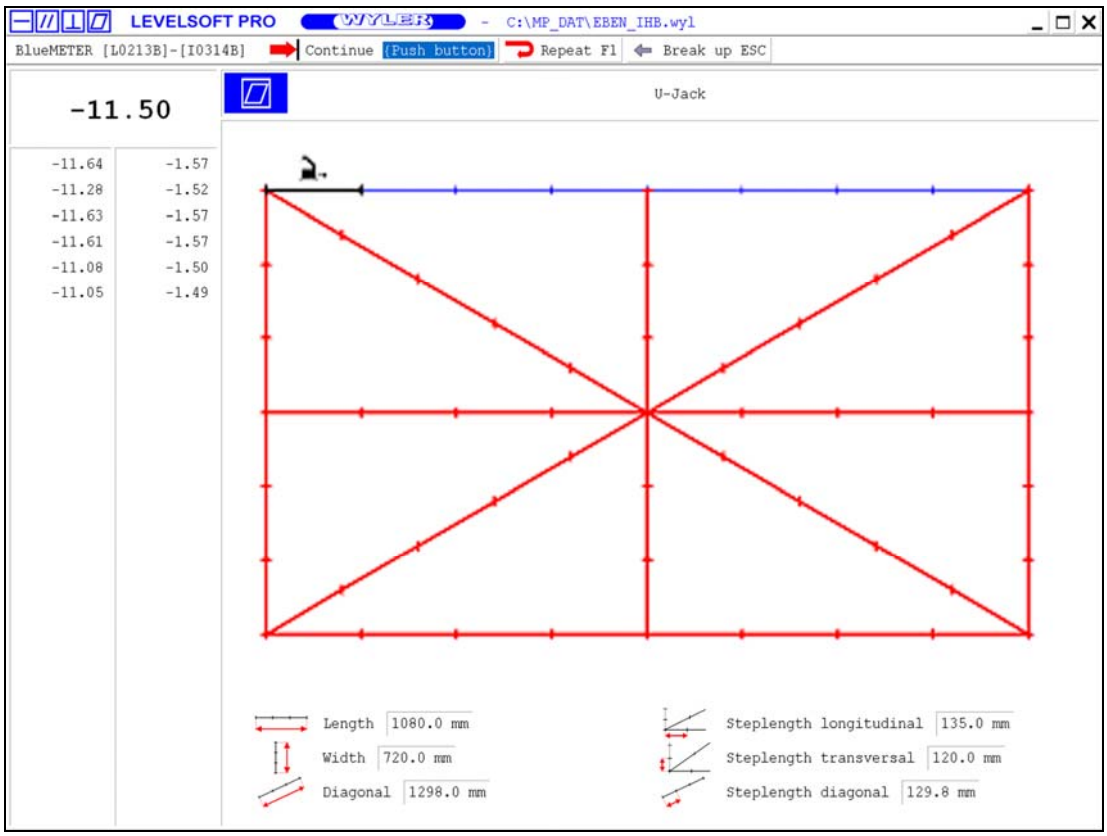
Based on this pre-view the user can decide to **repeat the measurement of one of more lines**. To do this action the key <Repeat Measurement> / [F2].



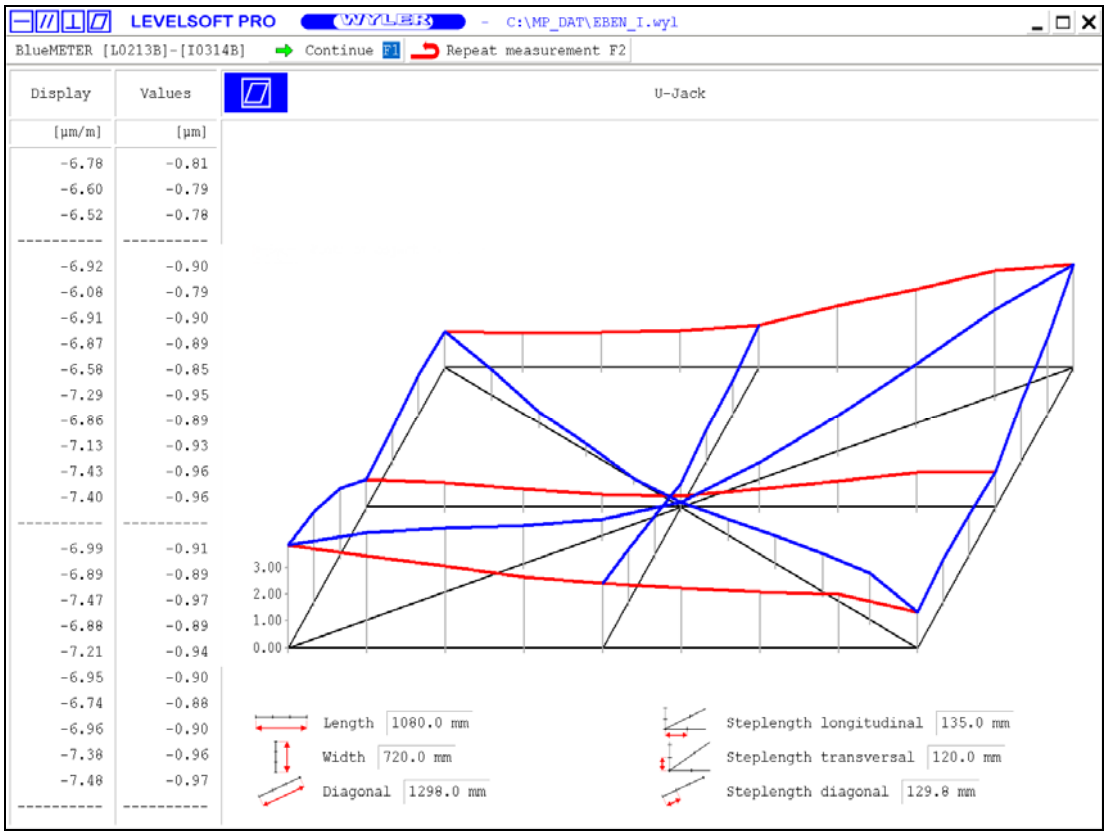
Click with the mouse on the line, resp. lines, you intend to measure again and confirm your selection with <Confirm> / [F1]. In our example we will repeat the measurement of the third longitudinal line.

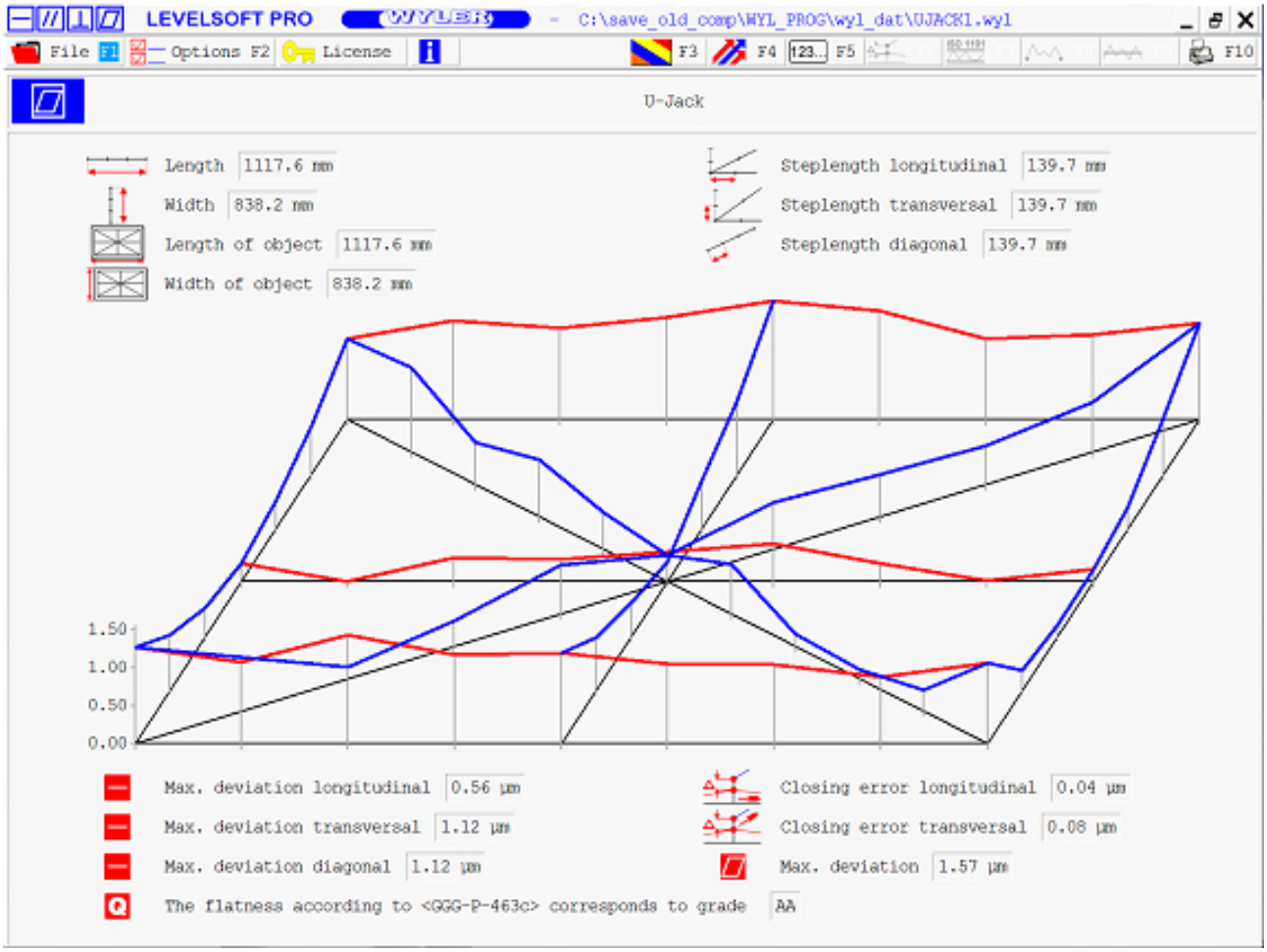


The respective line can now be measured again. After completing the measurement the menu <Pre-view> / [F2] will allow again to repeat the measurement of one or more lines.



If the measurement corresponds to the target it can be definitely finished with <CONTINUE> / [F1] (see picture)





The maximum **Flatness Error** is 1.12µm,
the closure error longitudinal is 0,70µm and the closure error transversal is 0,38µm

The surface quality according to DIN 876 corresponds to **quality "00"**. The standard may be changed by using <Options> / [F7]. The display of the quality information may also be completely omitted.
Additional information concerning Quality according to different standards can be found in chapter "4.7.17. Change flatness standard" and chapter "6.2. Detailed information concerning the theme ‘Standards’ /Quality of the measured object"

Closure error

- "Closure error longitudinal" is the closure error between the longitudinal line and the connection point of the diagonal lines.
- "Closure error transversal" is the closure error between the transversal line and the connection point of the diagonal lines.
- The "Maximum error longitudinal/transversal/diagonal" is the maximum straightness error of the different lines.

Remarks concerning the closure errors:
The closure error is an important indication on the quality of the measurement respectively of the measuring uncertainty to be considered.

The other steps

- Display in colour [F3]
- Switch between graphical display and measuring pattern [F4]
- Display measured values [F5]
- Printing

are identical to measuring a line.

Option B: **WYLER Flex base** 250mm
100mm ... 240mm (possible step length variation of the base)
70mm … 270mm (extended range)

The flexible base of WYLER

For many years we have faced customers' requests for WYLER instruments with a measuring base allowing adjustable step length. Considering the technical requirements and in order to avoid any negative influence of such a base on the quality of the measuring results, intensive tests with a variety of models and versions have been performed.
As a result of this development series we are now in a position to launch the **WYLER Flexbase.** The users will be excited by the easy handling and the multiple options available. This base is conceptually adopted from the standardised 3-point-supported measuring bases, which also makes the use of the U-Jack-method a lot easier.

Particularly in combination with the latest version of our software **LEVELSOFT PRO** this measuring base is a convincing enhancement. This software allows the automatic calculation and proposal of a suitable measuring layout in an easy way, taking in account the high variety of possible step lengths provided by the Flexbase.

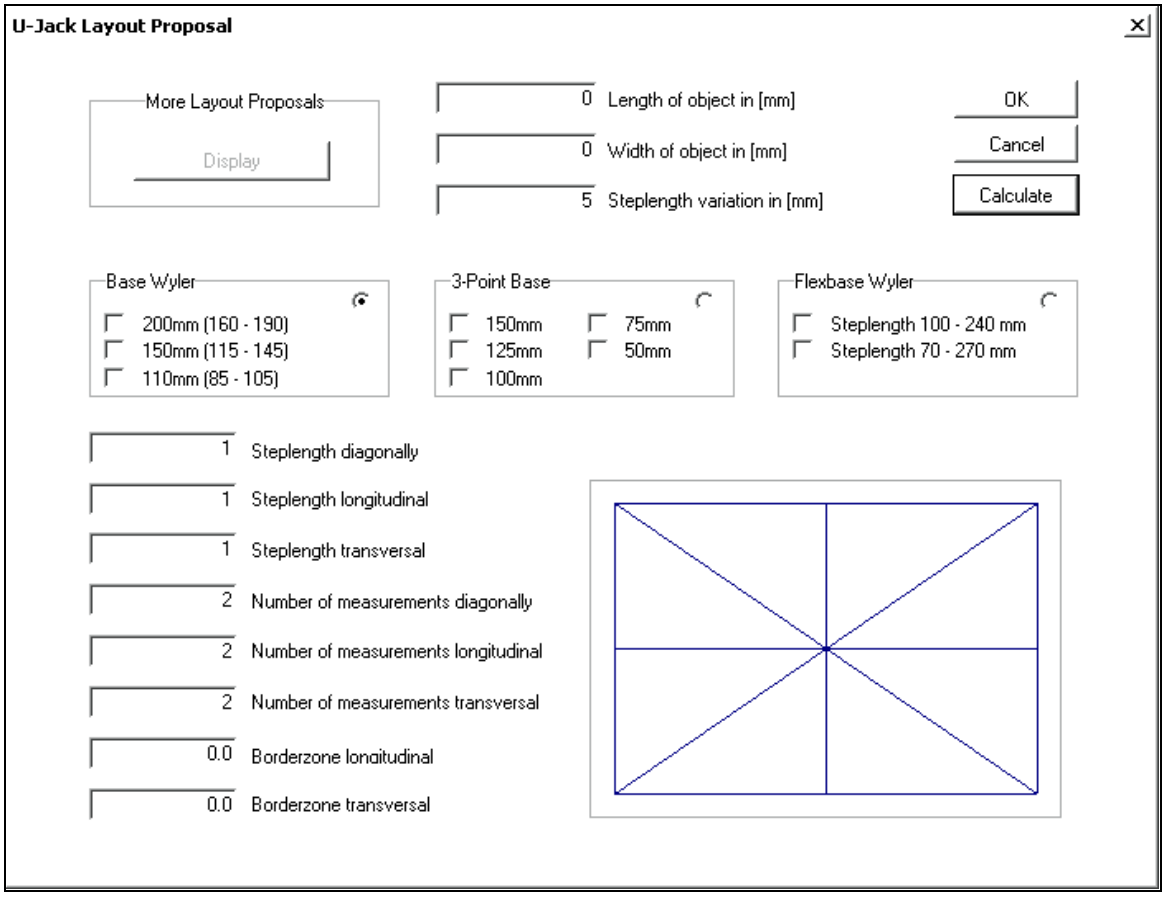
Additional advantages

- The base features a scale, allowing an easy adjustment of the step length
- Easily visible marks allow a precise positioning of the base during the measuring procedure
- Experienced users can easily displace and re-adjust the support plates for enlarging the range of possible step lengths considerably

Technical data of the WYLER flex base:

- Base length and width: 250 x 45mm
- Adjustable step length standard 90 (100)mm to 240mm
- Extended step length 70mm to 270mm
- Dimensions of 3-Point Tungsten carbide base: Diam. = 0.4", Distance width = 1.4"

The sub window "U-Jack Layout Proposal" for the previously defined parameters appears



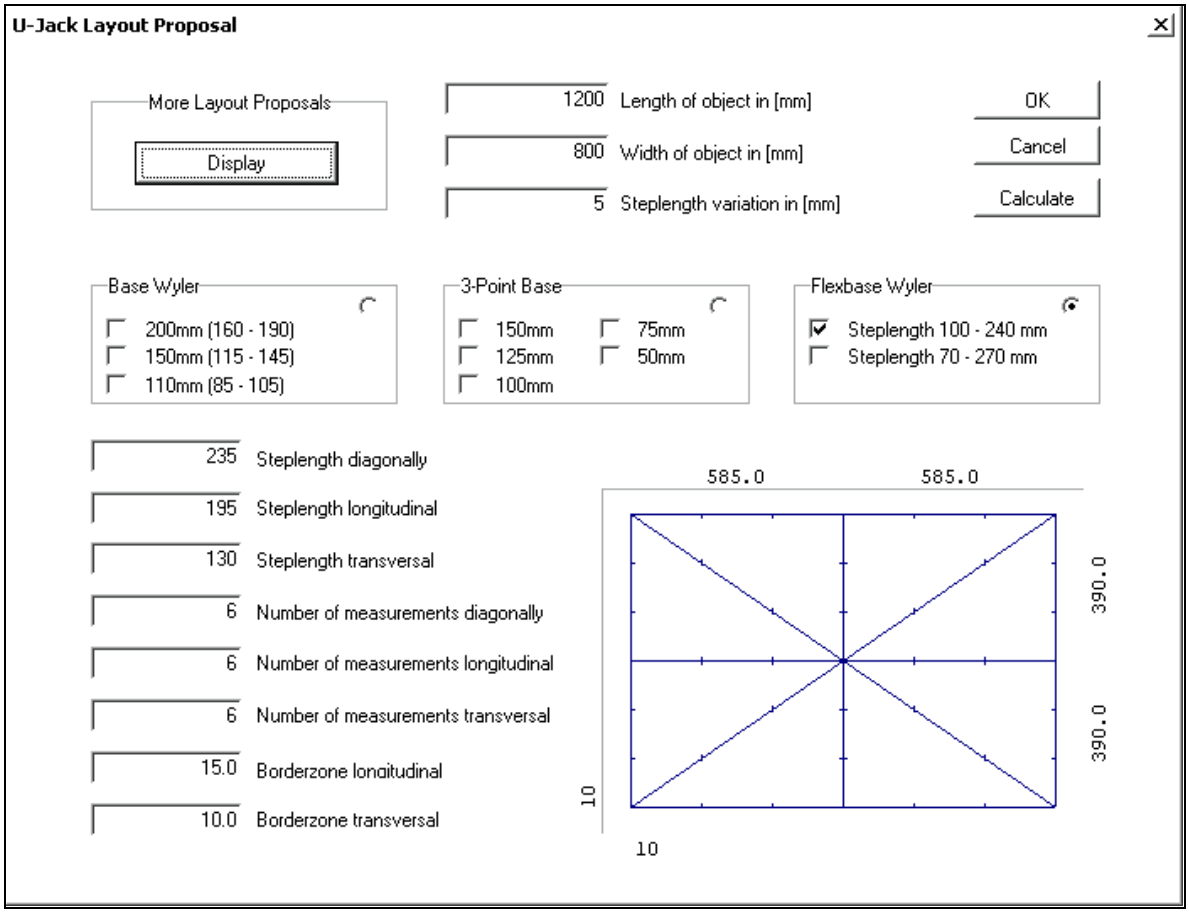
The length and the width of the object can be entered

- Length of object: 1200mm (Plate length)
- Width of object: 800mm (Plate width)
- WYLER flex base 250mm (100 … 240mm)

Procedure for data entering:

1. Entering the base length of the instrument used for longitudinal resp. transversal measurement
    a. WYLER flex base: 100 … 240mm
2. Entering the length and the width of the object
    a. Length of object: 1200mm (Plate length)
    b. Width of object: 800mm (Plate width)
3. With <Calculate>a first proposal will be generated

The software is now calculating a first series of possibilities using the base length set (In our example WYLER flex base 100 … 240mm)



The data will be displayed in the monitor lower left side and can be used for a check

In a first step the following parameters will be computed

- Step length diagonally: 235mm
- Step length longitudinal: 195mm
- Step length transversal: 130mm
- Number of measurements diagonally: 6 total
- Number of measurements longitudinal: 6 total
- Number of measurements transversal: 6 total
- Border zone longitudinal: 15mm
- Border zone transversal: 10mm

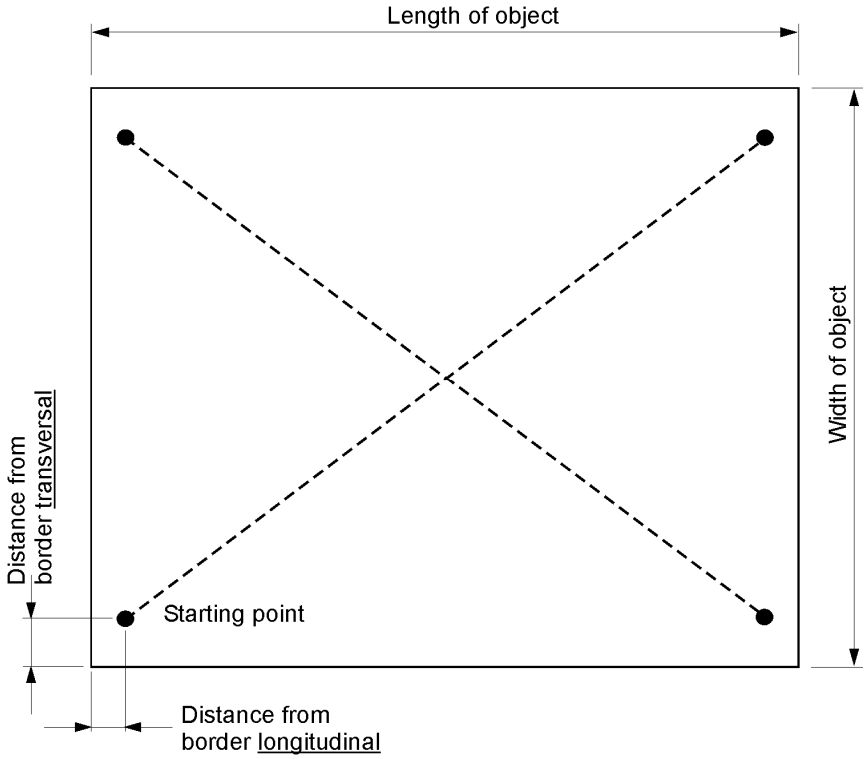
In addition the following information is displayed in the monitor

- Half length of the longitudinal lines 3x195mm = 585mm
- Half length of the transversal lines 3x130mm = 390mm
- Distance of beginning and end point of the diagonal
    - Distance from border longitudinal 10mm
    - Distance from border transversal: 10mm

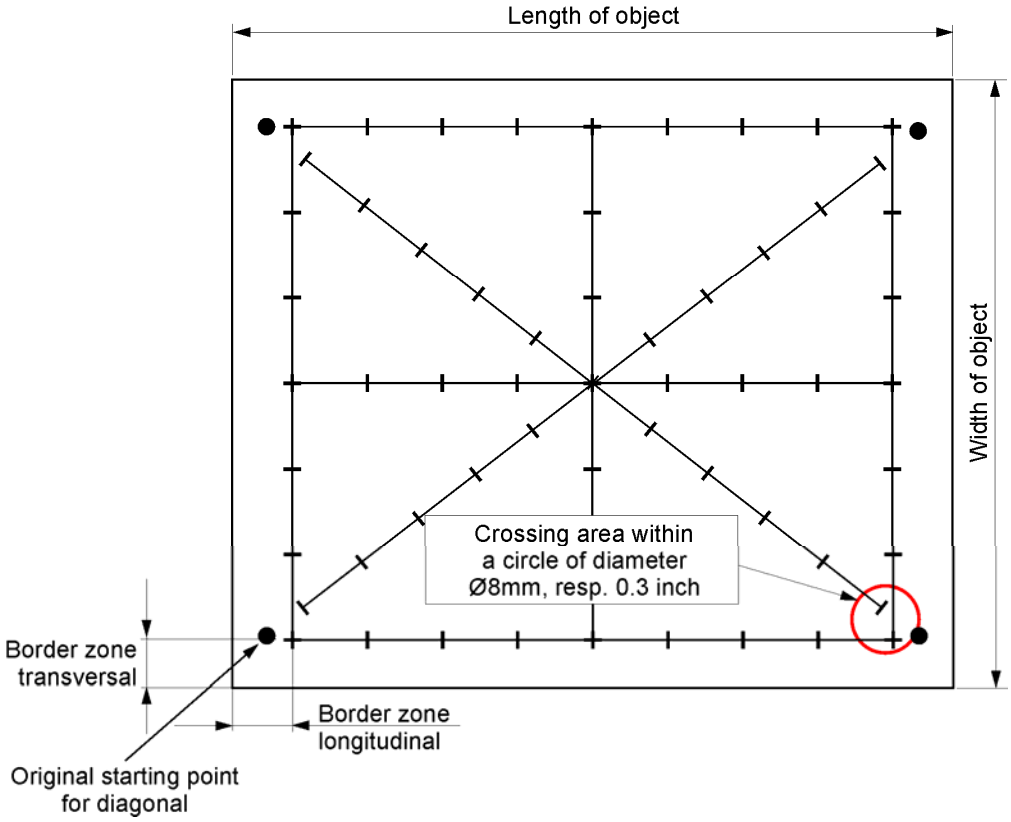
The beginning and endpoint of the diagonal is not in every case on exactly the same spot as the longitudinal respectively the transversal lines are. According to the specification the crossing points must lay within an area with a diameter of 8 mm respectively 0.3”. The graphic below gives additional information to this.

Drawing the layout:

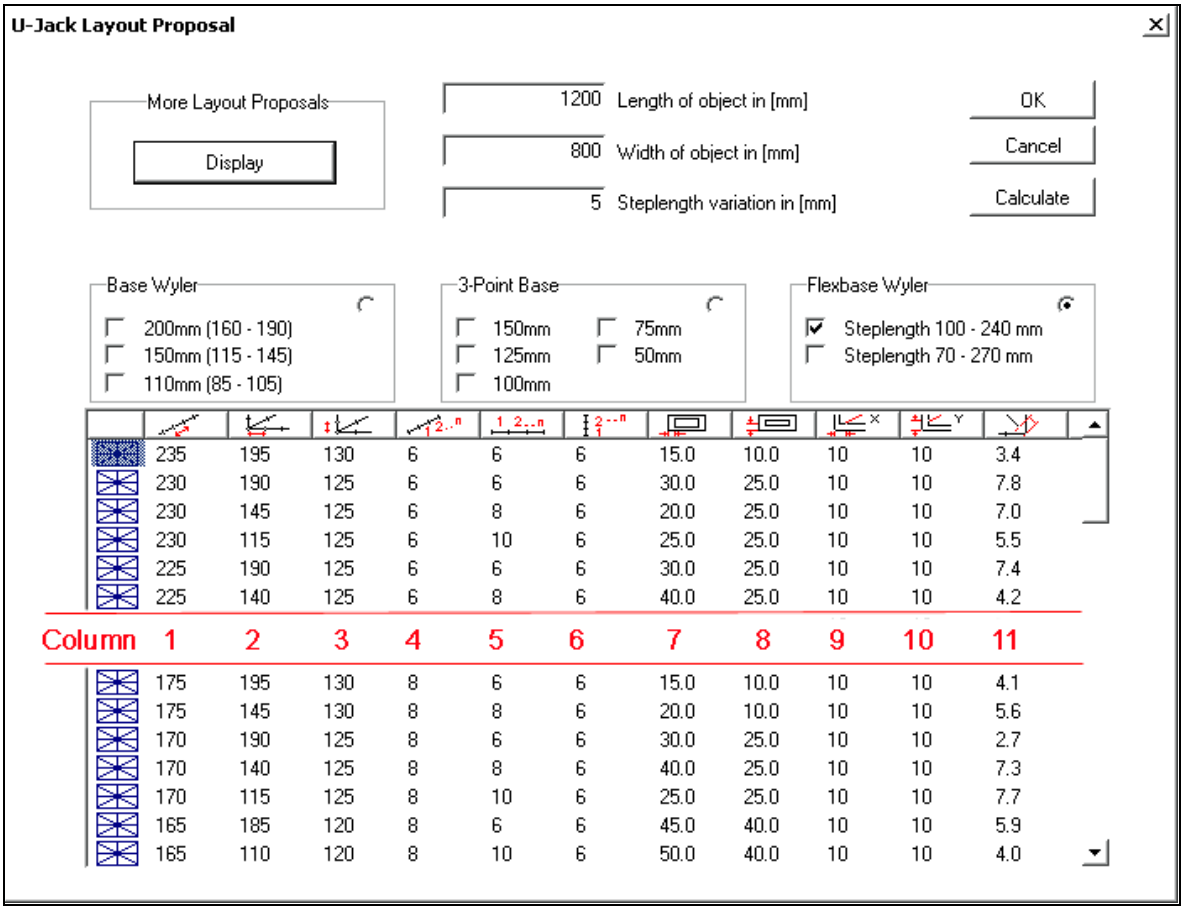
1. Step:
Drawing of the diagonals (starting at 5 mm transversal / 5 mm longitudinal)



2. Step:
Drawing the definite diagonals with the step length of 235 mm
Drawing of the longitudinal and transversal lines starting at the centre by applying the correct border zone (starting at 5 mm transversal / 5 mm longitudinal) and step length. The longitudinal and the transversal lines are always meeting at the same spot.



In case the initial proposal is not meeting the requirements the possibility exists for displaying additional proposals. Press the key <Display> in the field "More Layout Proposals"



A number of additional proposal appear in list form whereas the following explanation is given for understanding the details:

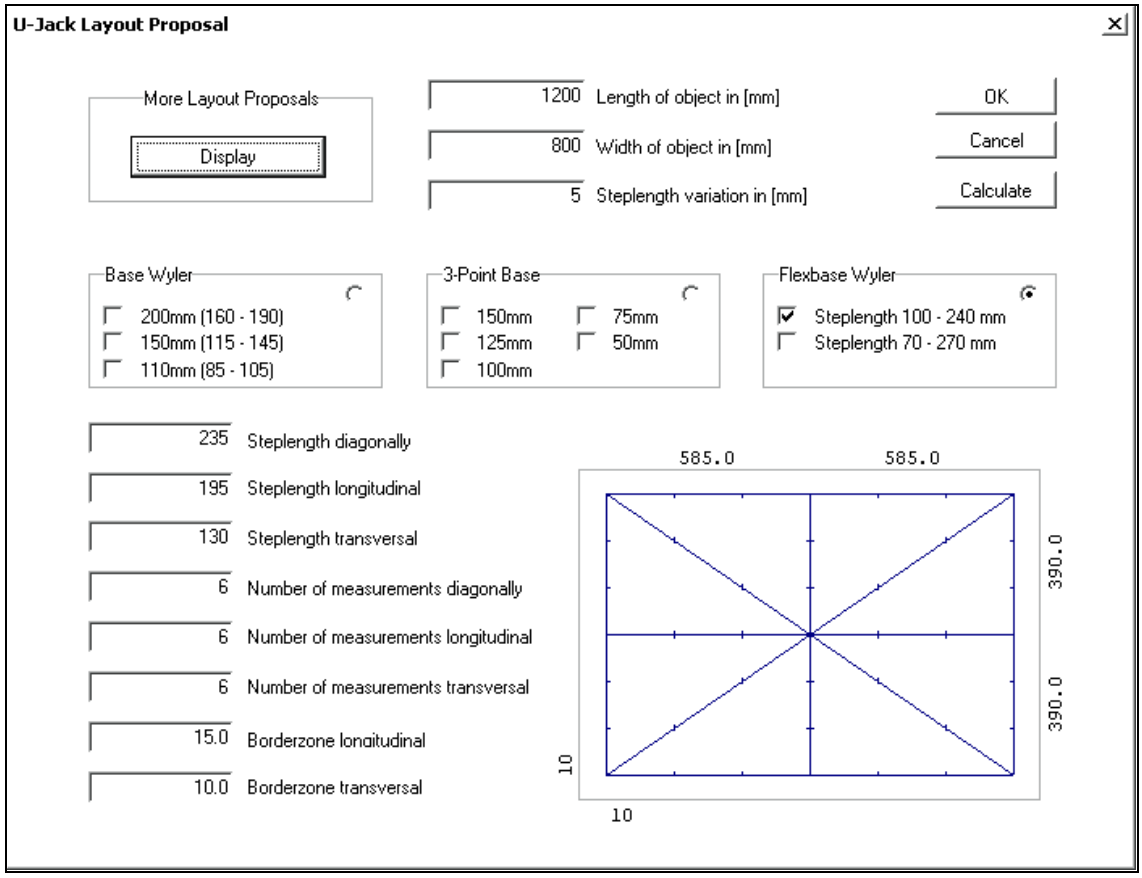
- Column 1 … 3: Step length diagonal. longitudinal and transversal
- Column 4 … 6: Number of steps diagonal, longitudinal and transversal
- Column 7 + 8: Border zone longitudinal, transversal
- Column 9 +10: Beginning and endpoint of diagonal (distance from borders)
- Column 11: Distance of the crossing point of the longitudinal and the transversal lines to the diagonal endpoint

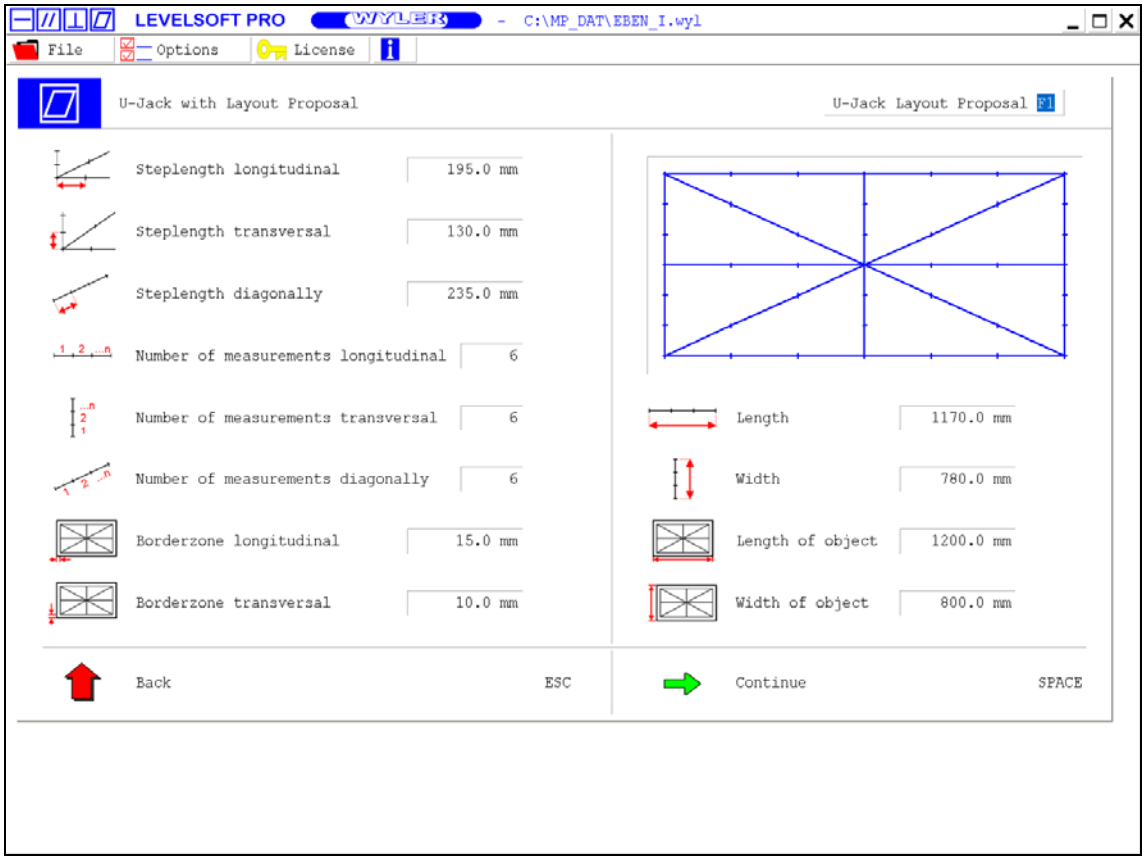
The individual columns can be sorted according to different criteria by clicking to the respective icons of the columns. The original setting is achieved by clicking to the free space in the upper left corner.

The chosen proposal is now selected by **double click to the U-Jack** symbol.

In our example we continue with the previously defined data!!!

The selected option will be integrated and displayed in the window for further actions

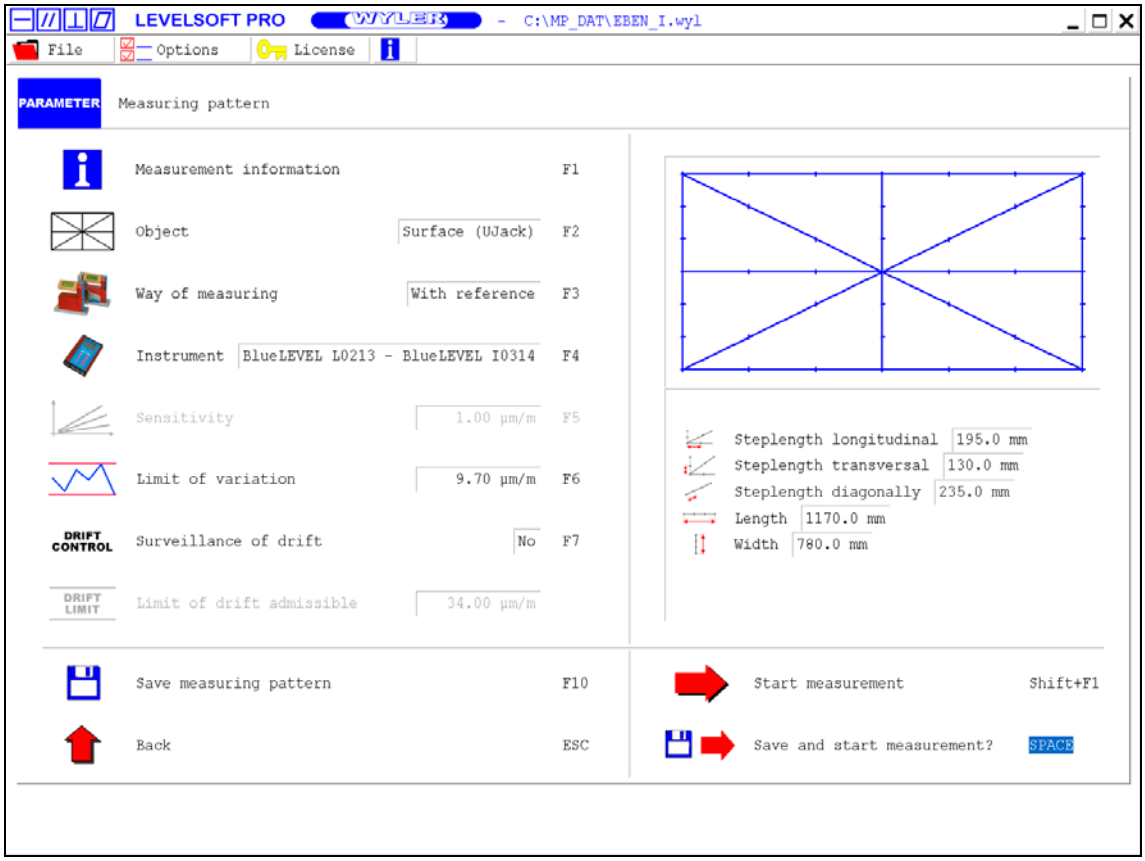




The parameters can now be checked again and then confirmed with <OK>. For additional proposals the function key <Display> can be applied from new and any other proposal may be selected.

After confirming with <OK> the complete pattern with the parameters is displayed.

Using <Continue> / [SPACE] the measuring procedure is ready for starting with the measurement of the object.



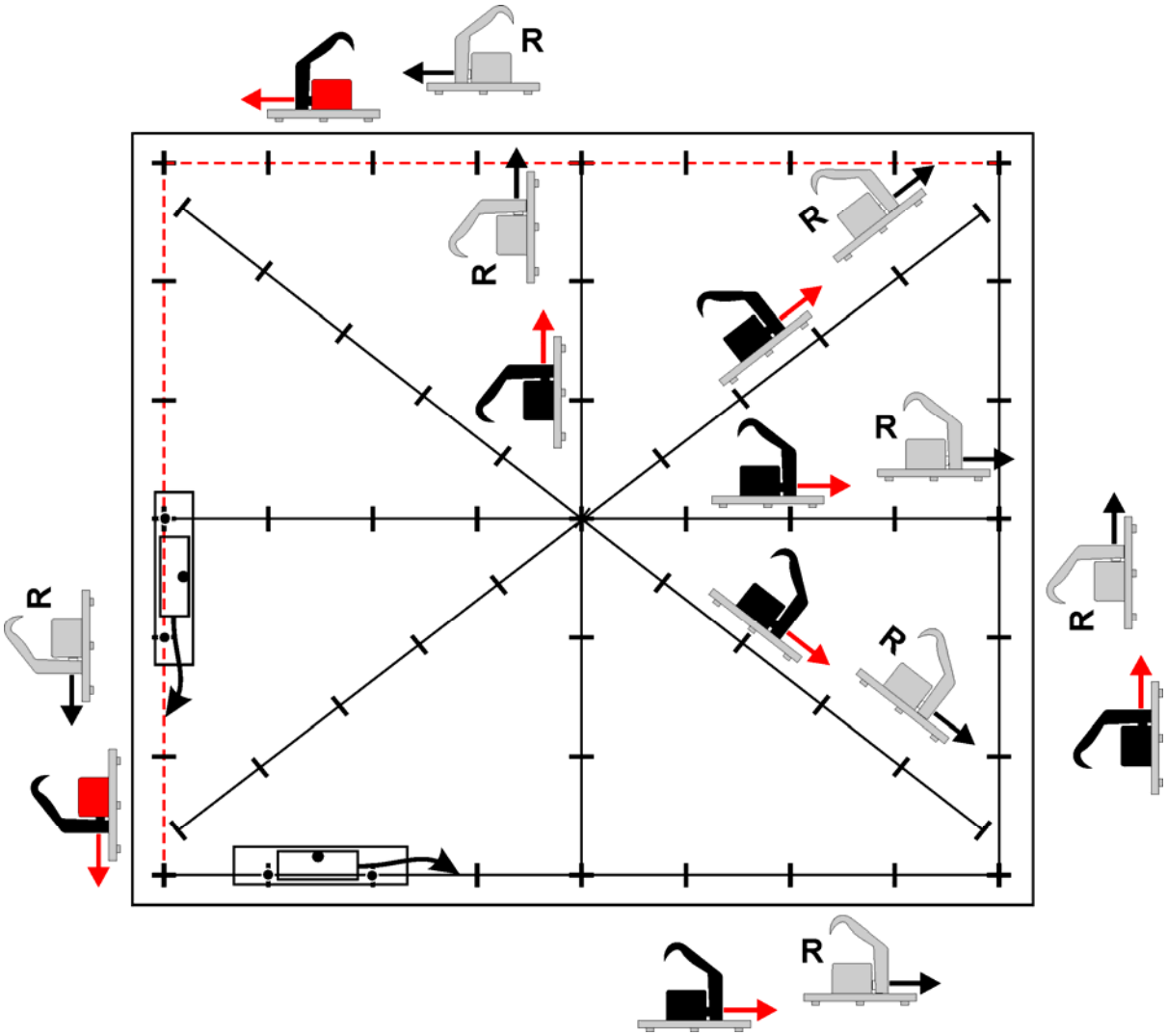
The other steps

- Way of measuring
- Limit of variation
- Surveillance of drift
- Starting the measurement with /without saving of the measuring pattern

are identical to measuring a line.

The U-Jack measuring procedure with a WYLER flex base

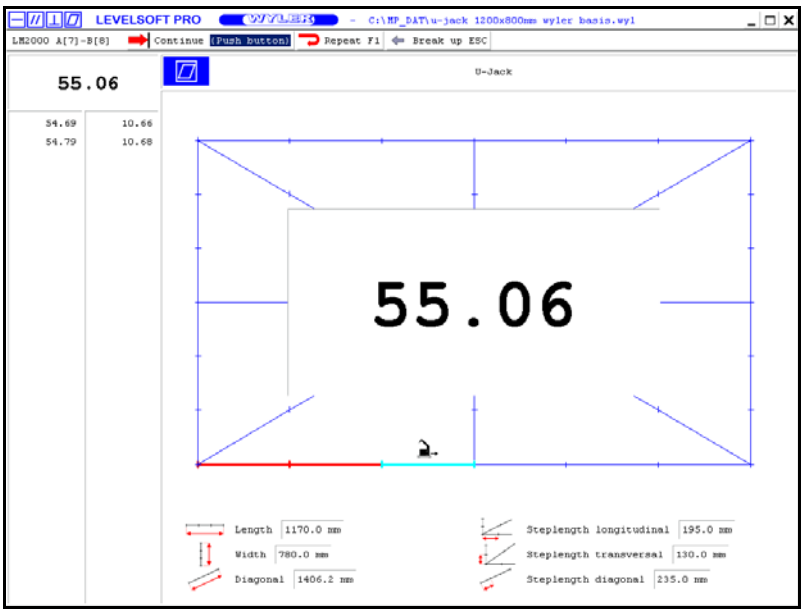
In order to measure the object in total length and width it is of greatest importance to turn the measuring instrument as well as the reference instrument at certain positions 180° around. The user will be guided to do so by means of a displayed picture during the measuring procedure.



As seen in the above picture the measuring as well as the reference instrument must be turned by 180°, without lifting the instruments off the plate, coming to the first transversal line and coming to the third longitudinal line. These positions are marked above with dotted lines.

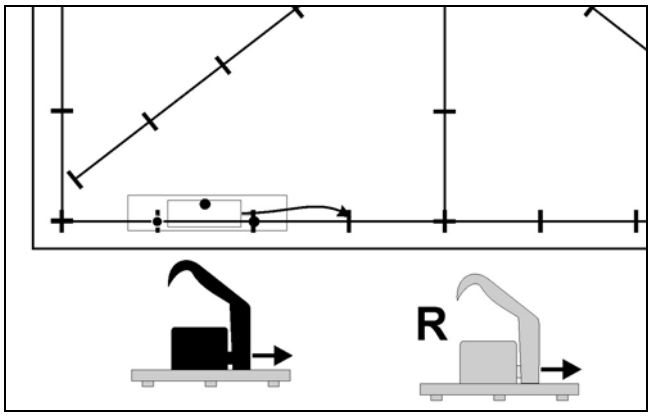
IMPORTANT: The **reference instrument (R)**, if used, must **always look in the same direction as the measuring instrument.**

The measurement can now start by using <Start measurement> / [F11]
Start measurement, with/without saving the measuring pattern is identical to measuring a line.

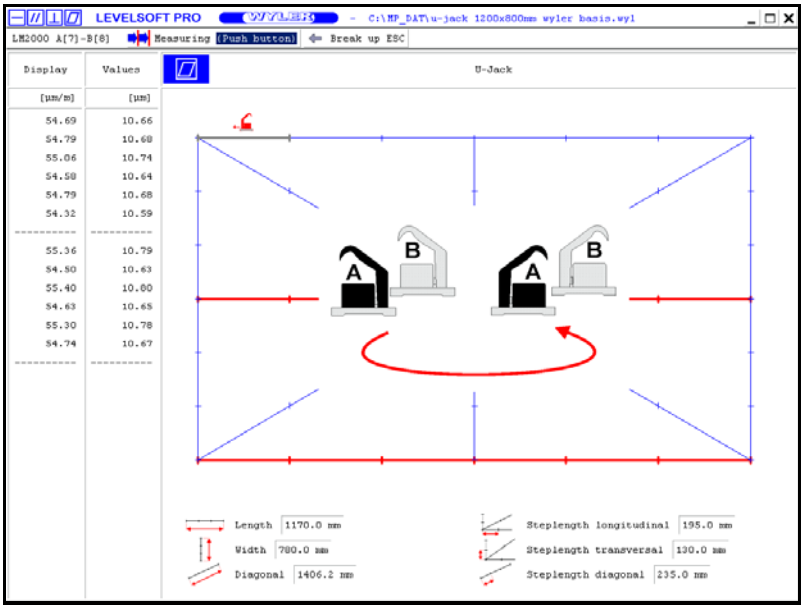


After successfully collecting the measurement data the value will be displayed on the screen for checking in large letters. When continuing with the confirmation of the value the displayed figures disappear and the new position where the instrument must be placed is seen.

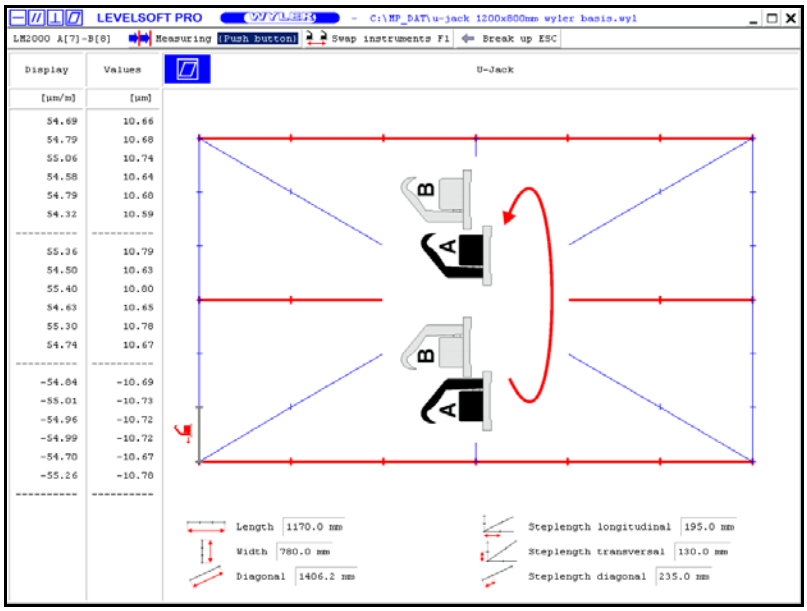
For the first two measuring lines the measuring as well as the reference instrument is set in measuring direction.



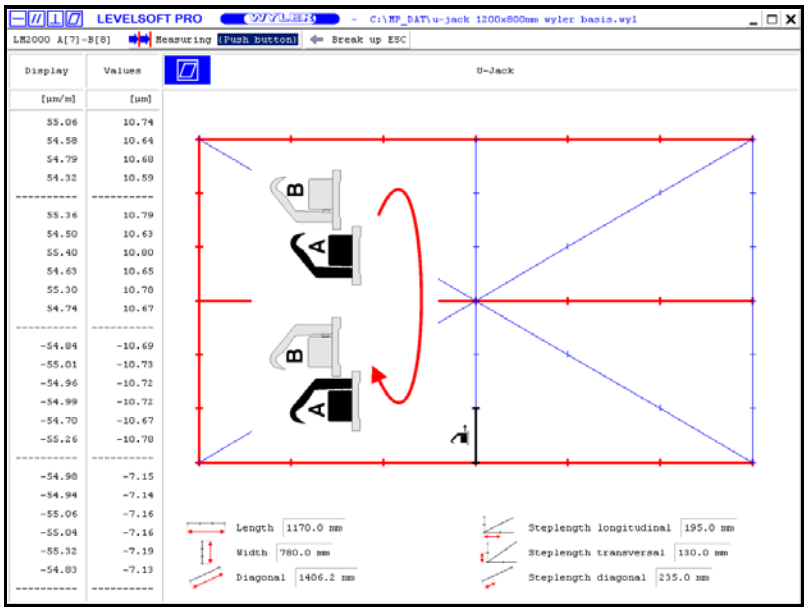
The two base pads must be placed symmetrically and precisely on the crossing points. (see sketch)



For the measurement of the third longitudinal line the measuring as well as the reference instrument must be turned by 180°. This means the connectors of both instruments are looking opposite to the measuring direction.

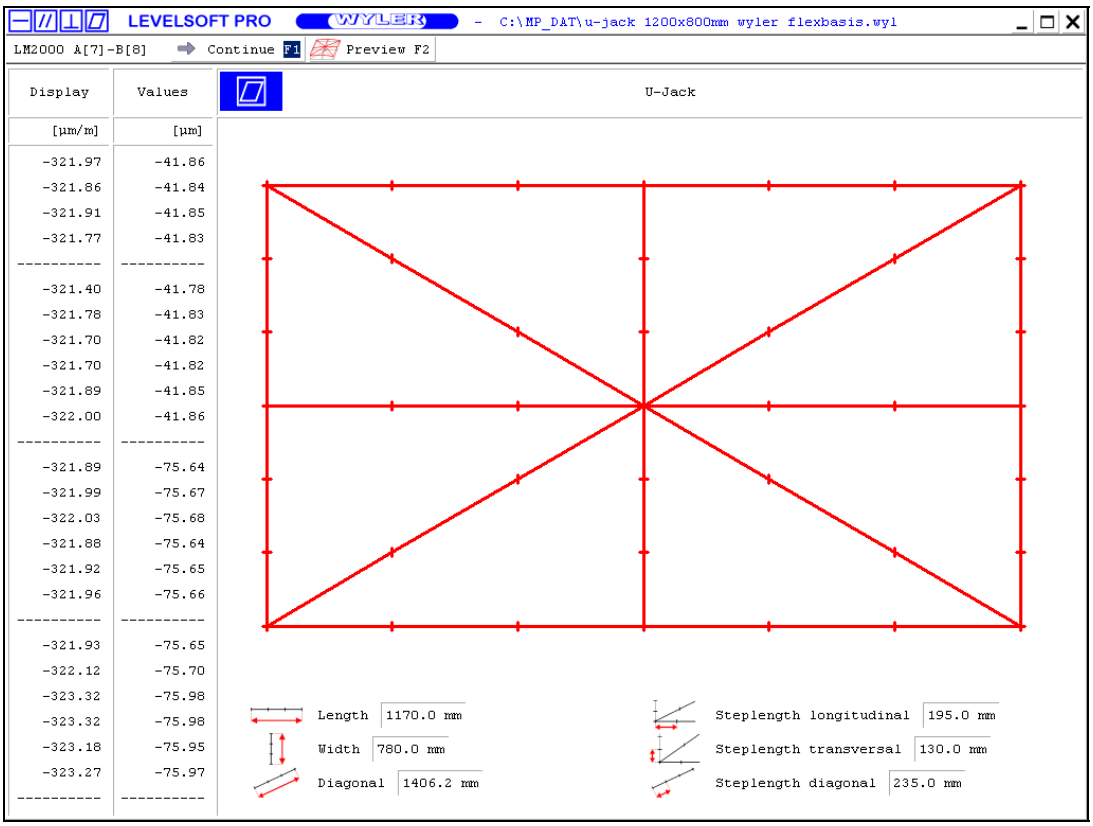


For the measurement of the first transversal line the measuring as well as the reference instrument must be turned by 180°. This means the connectors of both instruments are looking opposite to the measuring direction.

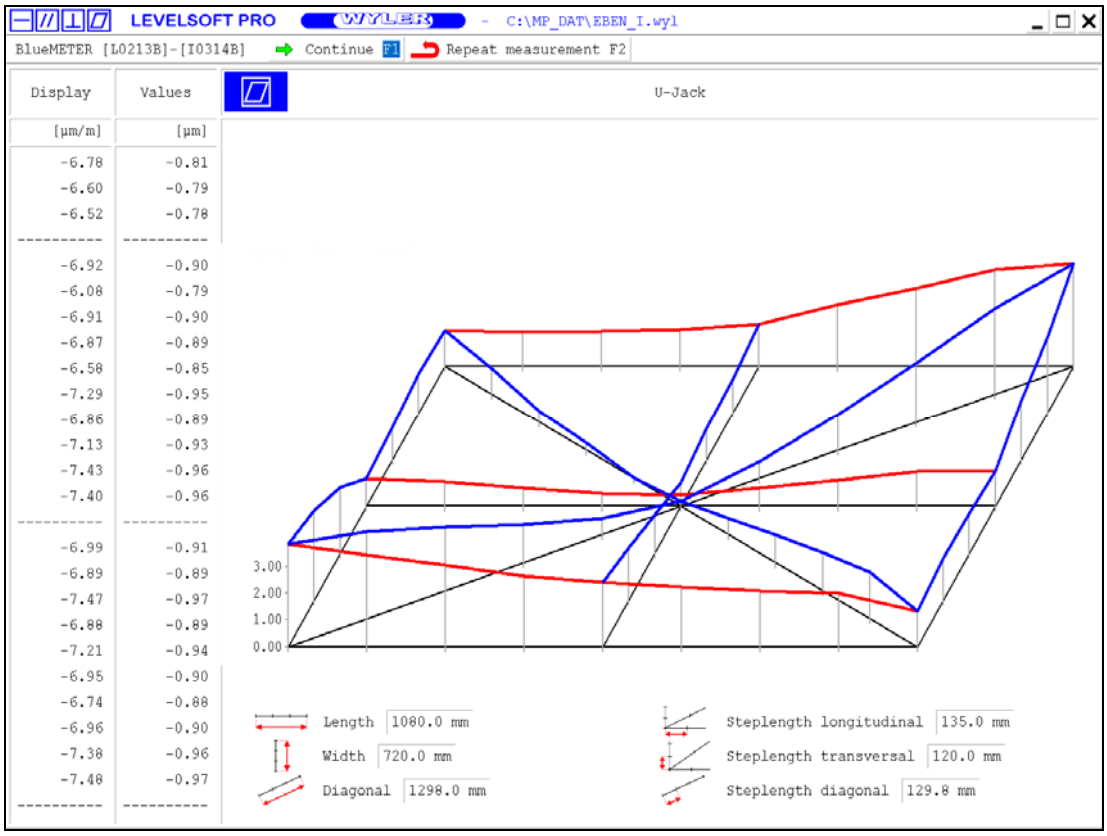


For the measurement of the second and third transversal line as well as the diagonal lines the measuring instrument as well as the reference instrument must be turned to have the WYLER standard position. This means the connectors on the instruments are looking in the measuring direction as usually set so.

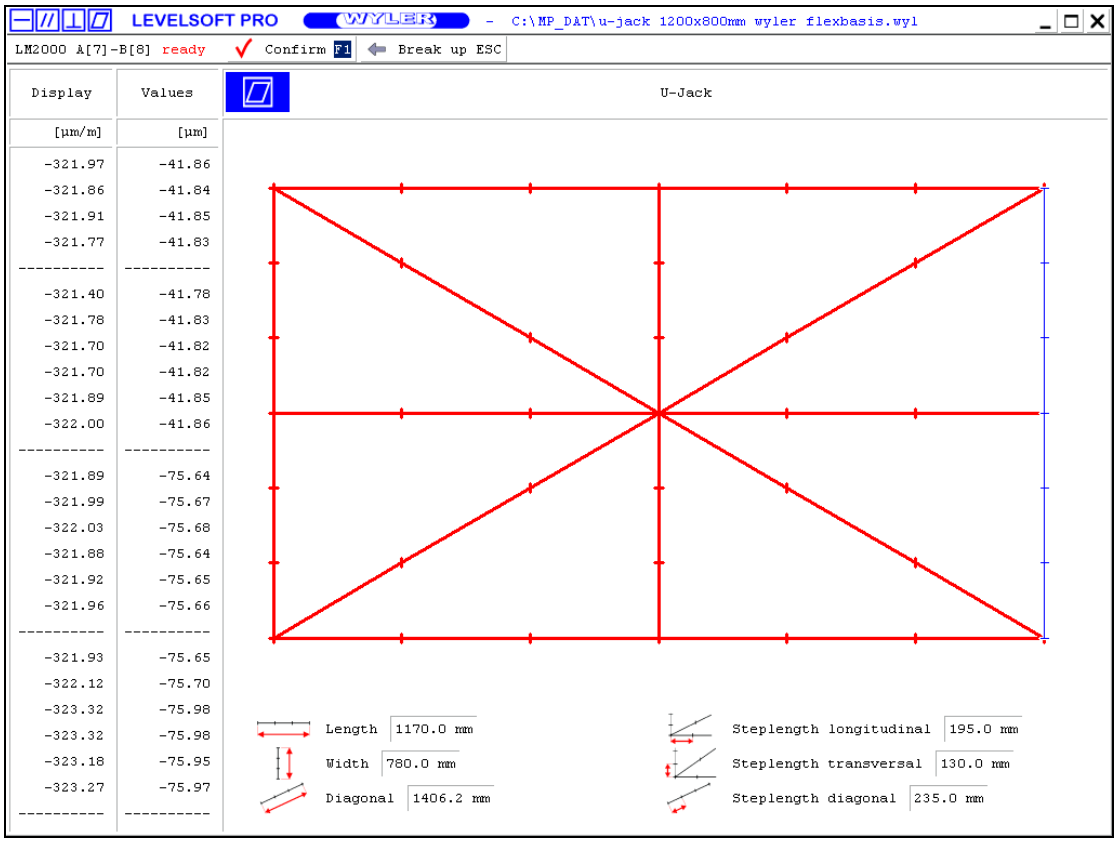
After the last measuring step the following screen will appear. With the icon <Pre-view> / [F2] the measured pattern can be viewed without completing the measurement definitely.



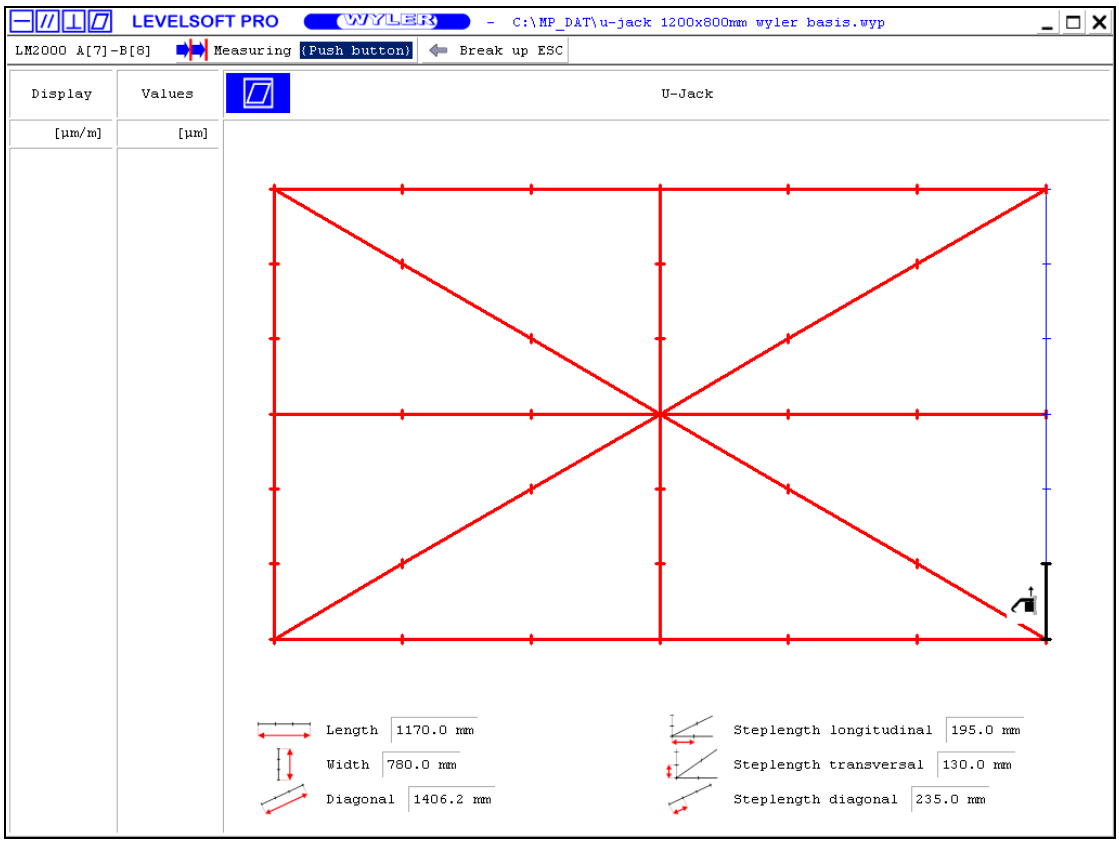
Based on this pre-view the user can decide to **repeat** **the measurement of one of more lines**. To do this action the key <Repeat Measurement> / [F2].



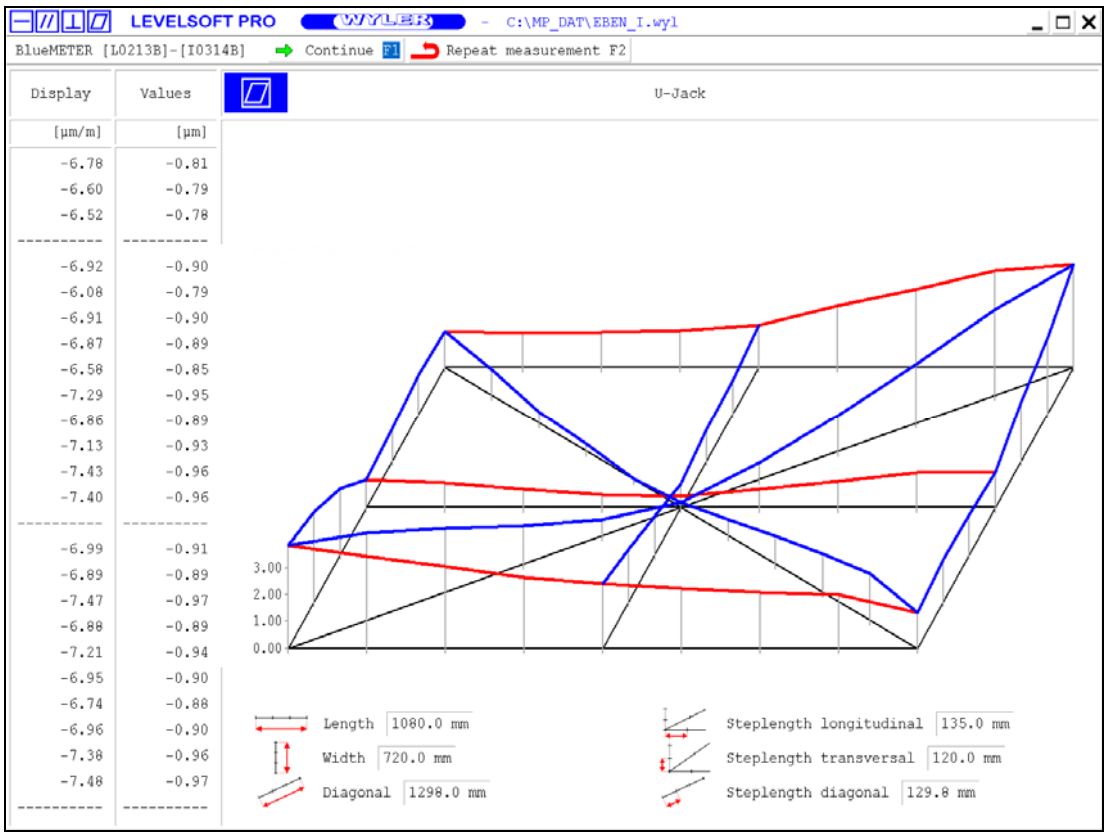
Click with the mouse on the line, resp. lines, you intend to measure again and confirm your selection with <Confirm> / [F1]. In our example we will repeat the measurement of the third transversal line.

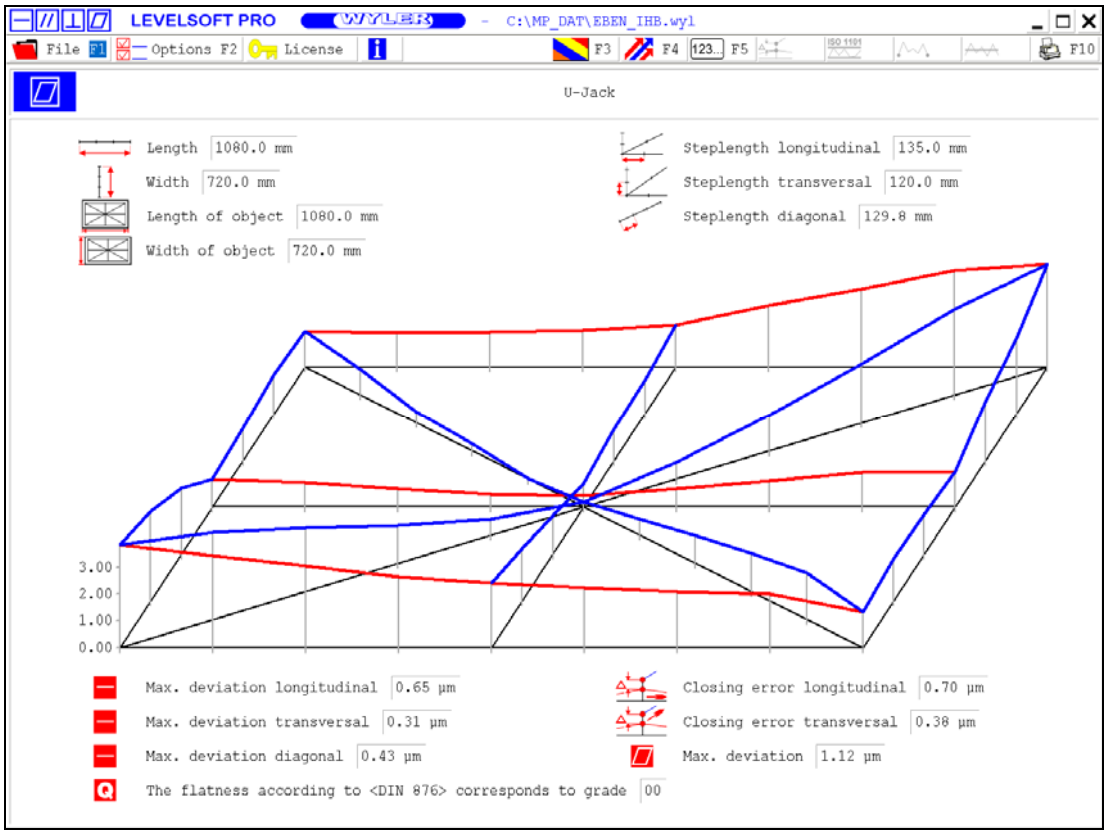


The respective line can now be measured again. After completing the measurement the menu <Pre-view> / [F2] will allow again to repeat the measurement of one or more lines.



If the measurement corresponds to the target it can be definitely finished with <CONTINUE> / [F1] (see picture)





The maximum **Flatness Error** is 1.12µm,
the closure error longitudinal is 0,70µm and the closure error transversal is 0,38µm

The surface quality according to DIN 876 corresponds to **quality "0"**. The standard may be changed by using <Options> / [F7]. The display of the quality information may also be completely omitted.
Additional information concerning Quality according to different standards can be found in chapter "4.7.17. Change flatness standard" and chapter "6.2. Detailed information concerning the theme ‘Standards’ /Quality of the measured object"

Closure error

- "Closure error longitudinal" is the closure error between the longitudinal line and the connection point of the diagonal lines.
- "Closure error transversal" is the closure error between the transversal line and the connection point of the diagonal lines.
- The "Maximum error longitudinal/transversal/diagonal" is the maximum straightness error of the different lines.

Remarks concerning the closure errors:
The closure error is an important indication on the quality of the measurement respectively of the measuring uncertainty to be considered.

The other steps

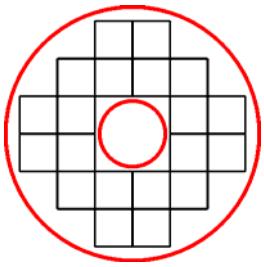
- Display in colour [F3]
- Switch between graphical display and measuring pattern [F4]
- Display measured values [F5]
- Printing

are identical to measuring a line.

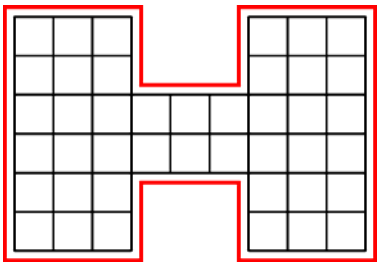
5.6.4 FLATNESS MEASUREMENT OF PARTIAL AREAS

This method can be chosen when only part of a surface is accessible due to some obstacles (Cut-outs, ring etc.)

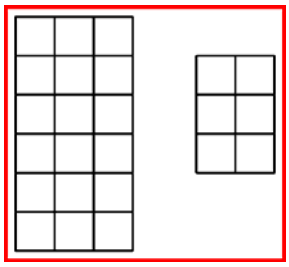
Example of objects which can be measured with this method.



Ring shaped objects



Areas with cut-outs (Table of machine tools)



Two surfaces of the same object, not directly linked together

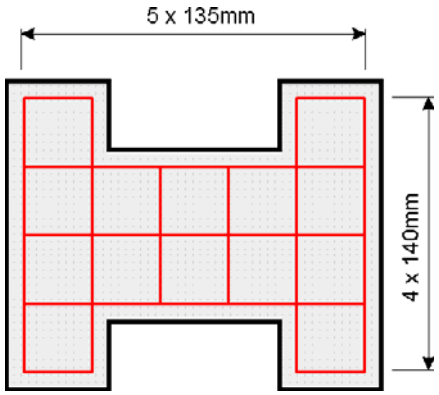
IMPORTANT:

It is important to be aware that the measuring uncertainty is increasing the more partial areas must be measured of the same object.

Example:
FLATNESS Measurement of a granite surface plate in the size of 550 x 300 mm / Differential measurement with two instruments

- Two instruments are connected to the PC via a Levelmeter2000
- Measuring object: Surface / Rectangle
- Step length longitudinal: 135 mm
- Step length transversal: 140 mm
- No. of longitudinal lines: 5
- No. of transversal lines: 6
- Measuring density long / cross: 1
- Base length of the instruments: 150 mm

Sketch of the object to be measured:



Remarks concerning the measuring objects "SURFACE"

Basically 4 measuring patterns are available

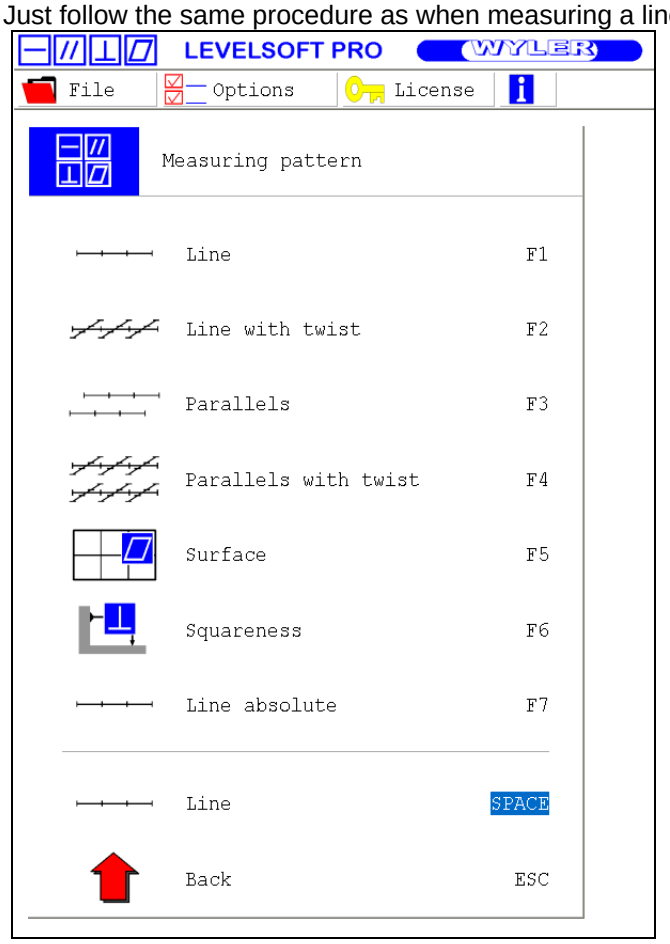
1. Rectangle	See chapter 5.6.2
2. WYLER (Grid)	See chapter 5.6.1
3. U-Jack	See chapter 5.6.3
4. Surface (partial)	Described in this chapter

Optimal step length in relation to the base length

Length of measuring base	Optimal measuring step length	Recommended range of measuring step length
110 mm	90 mm	85 ... 105 mm
150 mm	126 mm	120 ... 145 mm
200 mm	170 mm	160 ... 190 mm

The definition of the grid and the input of the parameters follow the pattern as described in chapter 5.6.1 "WYLER (GRID)

Just follow the same procedure as when measuring a line



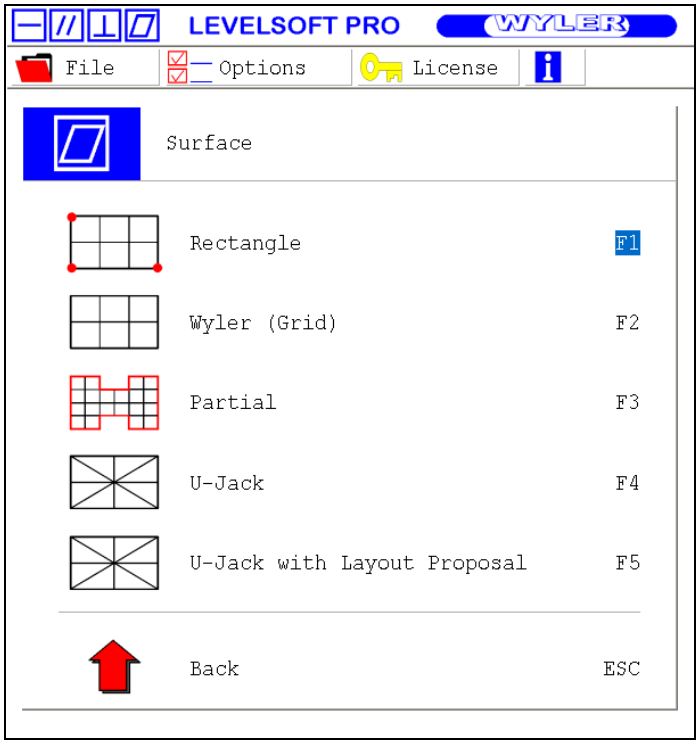
The following dialogue box is seen with the listing of the possibilities of the objects:

- **LINE**
  Measurement of lines
- **LINE WITH TWIST**
  Measurement of lines with twist
- **PARALLELS**
  Measurement of up to 3 parallels
- **PARALLELS WITH TWIST**
  Measurement of up to 3 parallels with twist
- **SURFACE (Flatness)**
  Measurement of surfaces, respectively flatness
- **SQUARENESS (Measurement of right angle)** Measurement of 90 deg. Angles
- **LINE ABSOLUTE**
  Measurement of a line with absolute values

In our example we chose Surface WYLER (Grid) [F5]

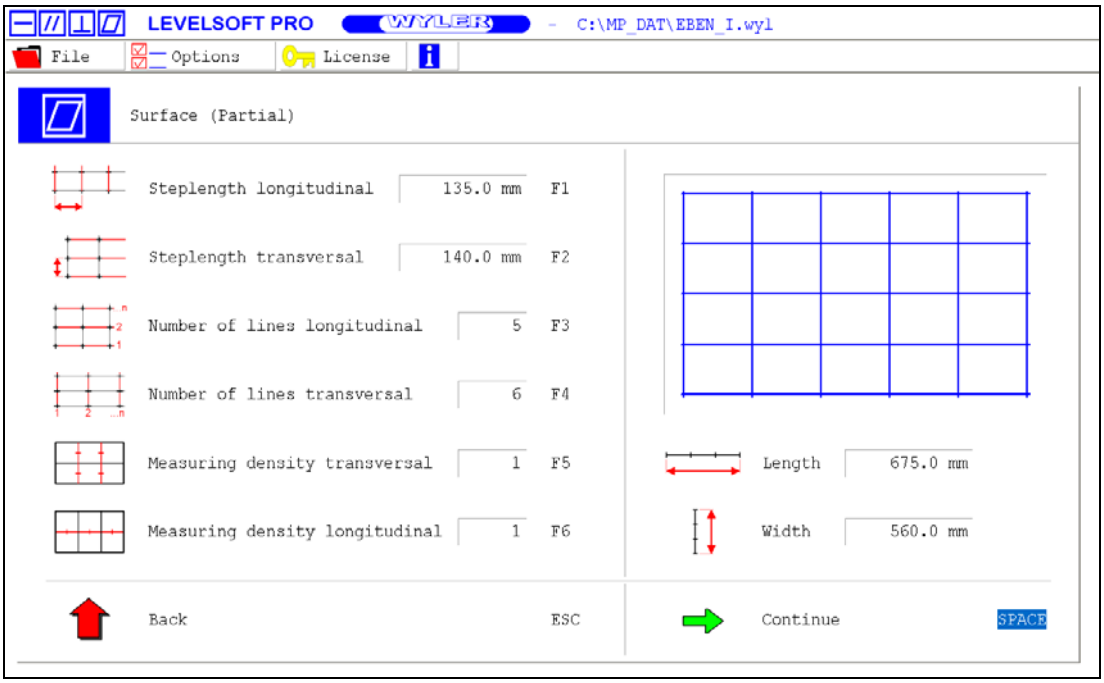
A number of three different options are available

- **Rectangle**
  The measured object is aligned in a way that the two endpoints of the first longitudinal line and the two endpoints of the first transversal line are on the same level.
- **Surface WYLER** / GRID
  Standard-measuring principle for flatness measurement with a grid
- **U-Jack** / US-Standard "GGG – P – 463 c"
  This method is mainly used in the US and in the UK. The mayor disadvantage compared with the "WYLER" method according to DIN 876 / Part 1, is the fact that the total surface of the object is not covered optimal.
- **Surface (Partial)** Partial surface area based on the "WYLER grid"
  This method can be chosen when only part of a surface is accessible due to some obstacles (Cut-outs, ring etc.)



In our example chose now
<PARTIAL> / [F3]

The entering mask for entering the previously determined measuring parameters appears (total grid without considering the cut-outs)

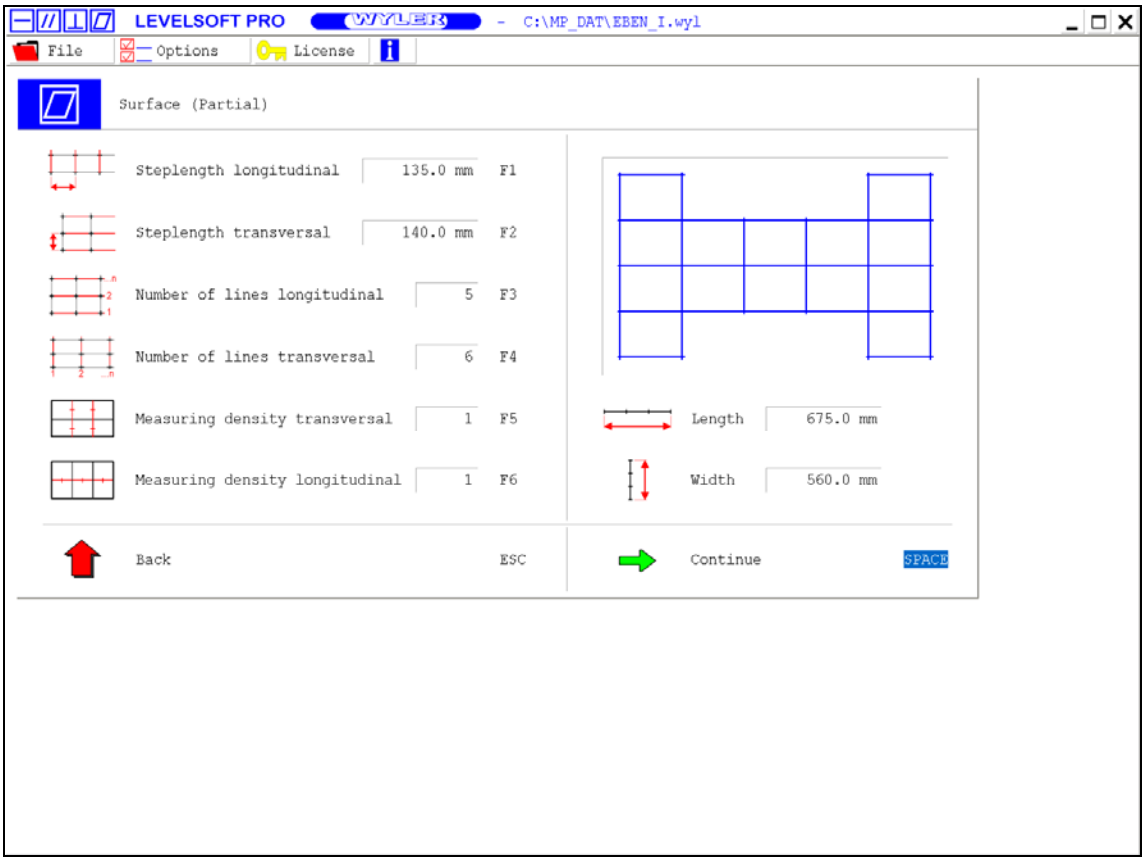


The following parameters must be entered now:

- Step length longitudinal 135mm
- Step length transversal: 140mm
- Number of measurements longitudinal: 5
- Number of measurements transversal: 6
- Measuring density longitudinal: 1
- Measuring density transversal: 1

The data is displayed in the monitor (top right) and can be accepted with <Continue> / [SPACE]

Following the initial set-up it is now required to do the detailed definition of the layout by **eliminate by mouse click the lines of the figure** which can not be measured.

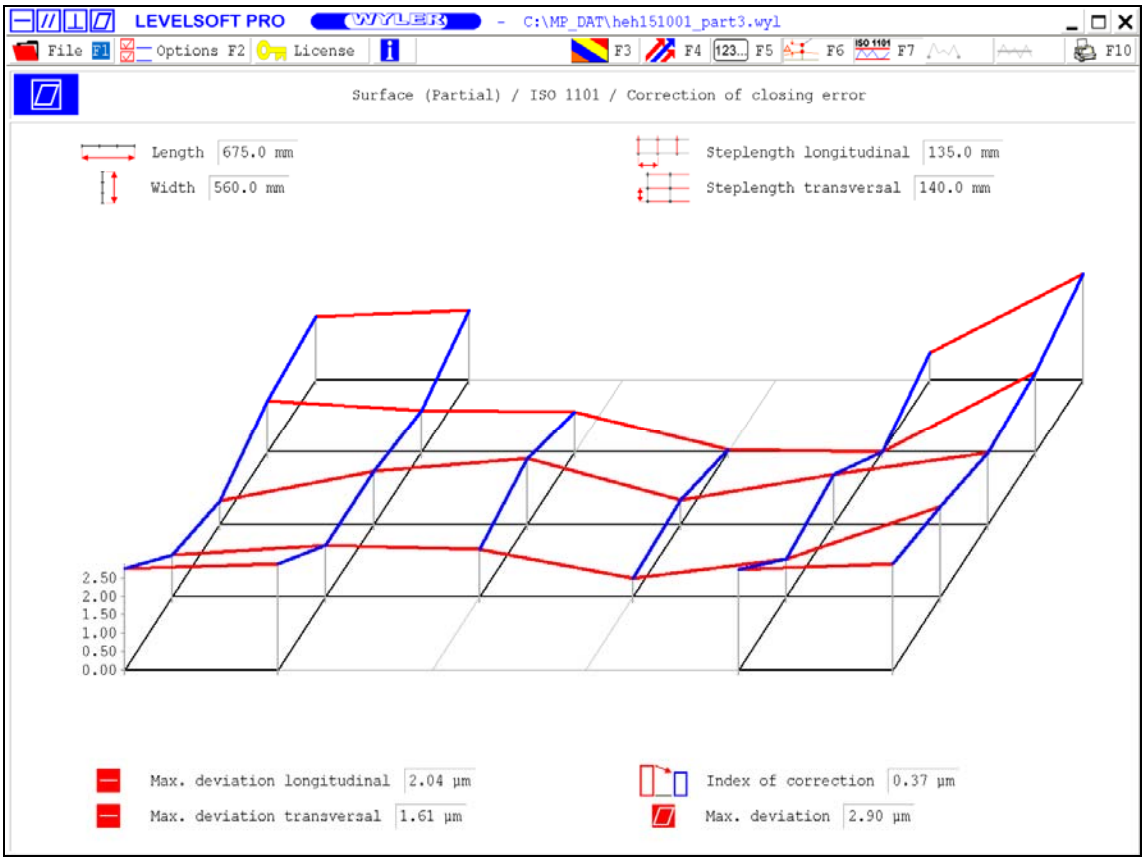


Start measurement, with/without saving the measuring pattern is identical to measuring a line
With <Continue> / respectively [SPACE] the layout will be accepted and

The other steps are identical to measuring a line:

- Way of measuring
- Limit of variation
- Surveillance of drift
- Start measurement, with/without saving the measuring pattern

is identical to measuring a line



Flatness of the surface according to ISO 1101, with correction of closure errors.
The maximum error of the surface is reduced to 2.90µm. Instead of the closure error the display shows now the "Index of correction" which is corresponding to the standard deviation of all the closure errors. (0.37µm)

The following steps

- Display in colour [F3]
- Switch between graphical display and measuring pattern [F4]
- Display measured values [F5]
- Printing

are identical to the measurement of a line.

Remarks concerning the correction of closure error:

- The correction of the closure error is computed according the method of arithmetic average of the different closure errors.
- The index of correction shows the maximum correction done at a measuring point.

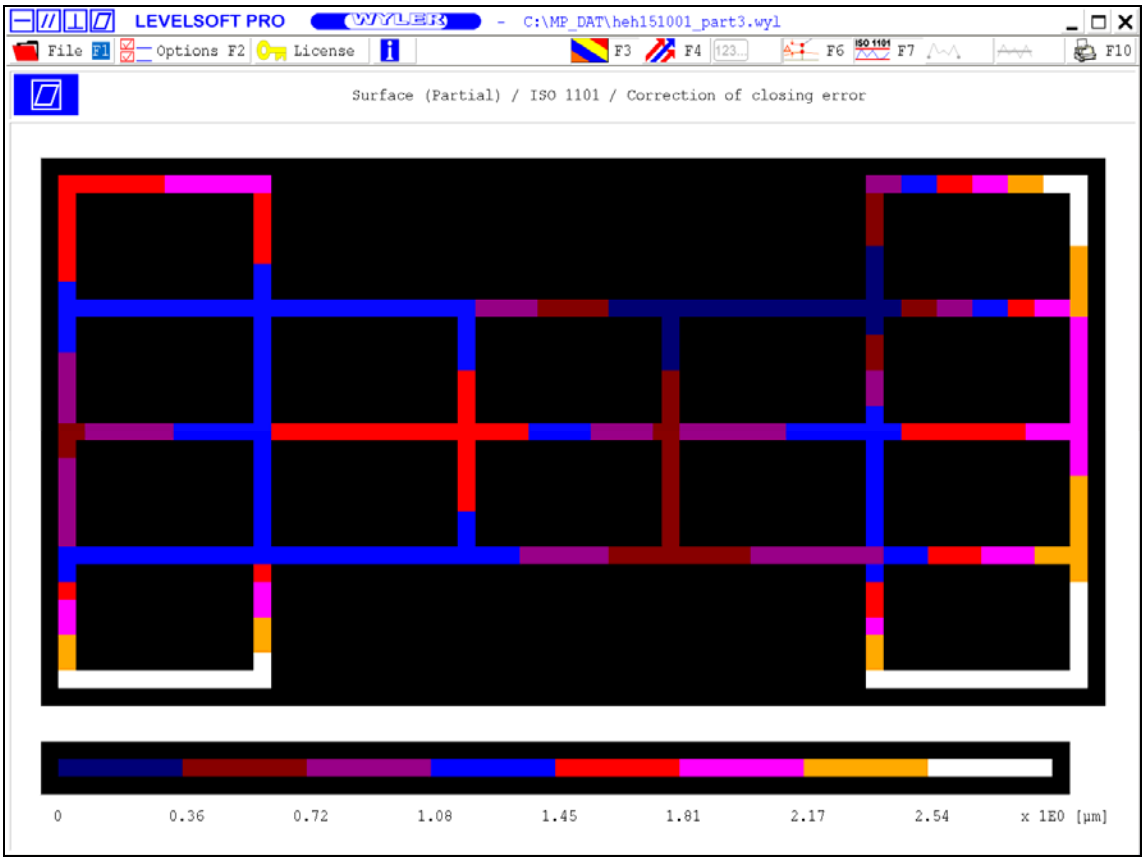
Display in colour graphic / Option 1

Using the key [F3]

/ [F3]

the profile may be displayed in colour

This display is easily memorized, making it especially suitable for applications where corrections are made by manual method (scraping, lapping surface plates). .



Different colours, each representing one band above the zero-plane, are used to show the errors. In order to evaluate the error-band represented by each colour, a scale is provided on the screen. In case of large errors, the values must be multiplied with the factor shown to the right side of the scale

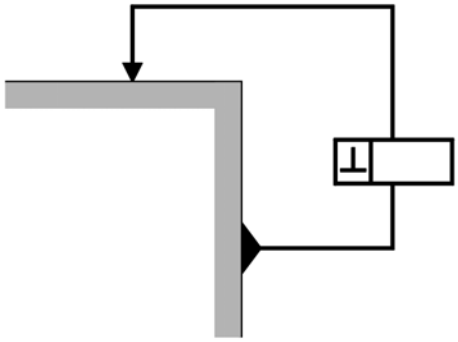
5.7 MEASUREMENT OF RIGHT ANGLE OBJECTS (SQUARENESS)

Measurement of 90 degree angles (Squareness) different geometrical objects

Example
Squareness measurement (differential measurement) with two instruments

- 2 Measuring instruments connected via Levelmeter 2000 to PC
- Object: 90 deg. angle, see arrangement
- Step length reference: 125 mm (vertical line)
- Step length 2nd line 125 mm (horizontal line)
- Number of measurements reference line 4 (vertical)
- Number of measurements 2nd line 4 (horizontal)
- Base length of the instrument is: 150 mm

Measuring task: Measurement of 90 degree angles (Squareness) with / or without previous determination of the instrument's angular error



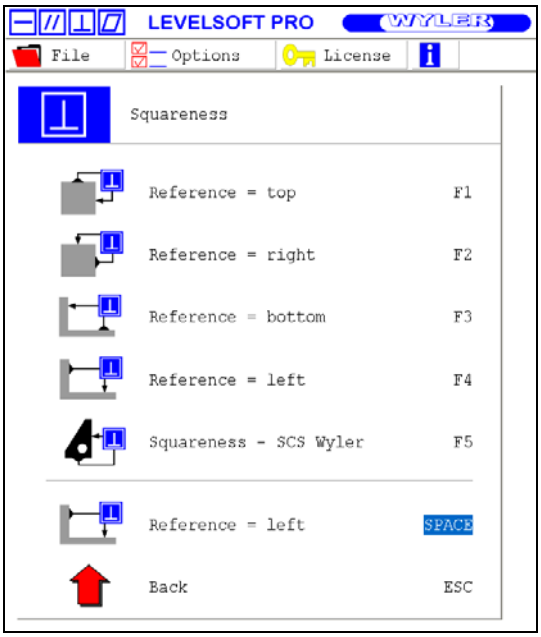
General procedure of the measurement

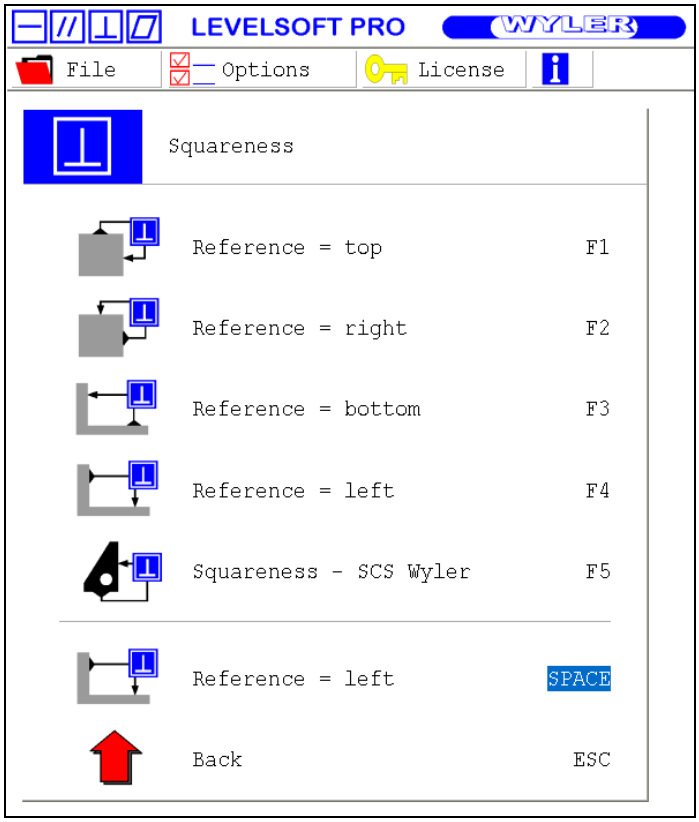
- The existing angular error of the measuring instrument is to determine by using a master granite square (this is not a must)
- After this the actual measurement is done according to the requirements in different steps as described below.

After the measurement is done different possibilities exist for the alignment of the reference measurement (reference line). The result of the measurement displayed will show three possible values depending on the alignment method chosen:

- Alignment according to the method "Endpoints"
- Alignment according to the method "ISO 1101"
- Alignment according to the method "linear Regression"

The following options are at your choice





In our example chose now
<Reference = right> / [F2]

The mask for entering the parameters is displayed.

The following parameters must be entered now:

- Step length reference: 125mm
- Number of measurements reference 4
- Step length 2nd line 125mm
- Number of measurements 2nd line: 4

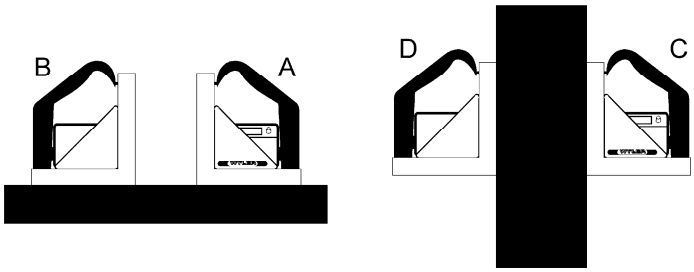
The data is displayed in the monitor (top right) and can be accepted with <Continue> / [SPACE]

The other steps are identical to measuring a line:

- Way of measuring
- Limit of variation
- Start measurement, with/without saving the measuring pattern

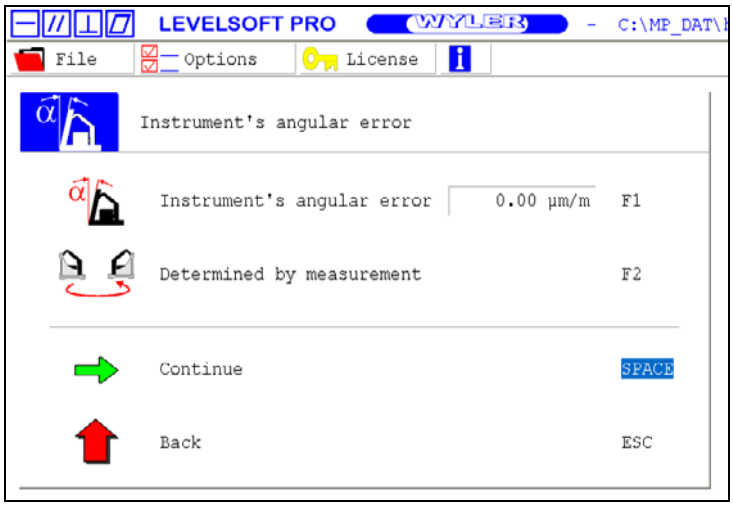
is identical to measuring a line.

The next step is the determination of **the instrument's error** which is done by two reversal measurements (horizontal and vertical) according to the sketch below.



Calculation of the index of correction, respectively
the angular error of the instrument

$$\text{Index of correction} = \frac{C + D}{2} - \frac{A + B}{2}$$



Two options exist:

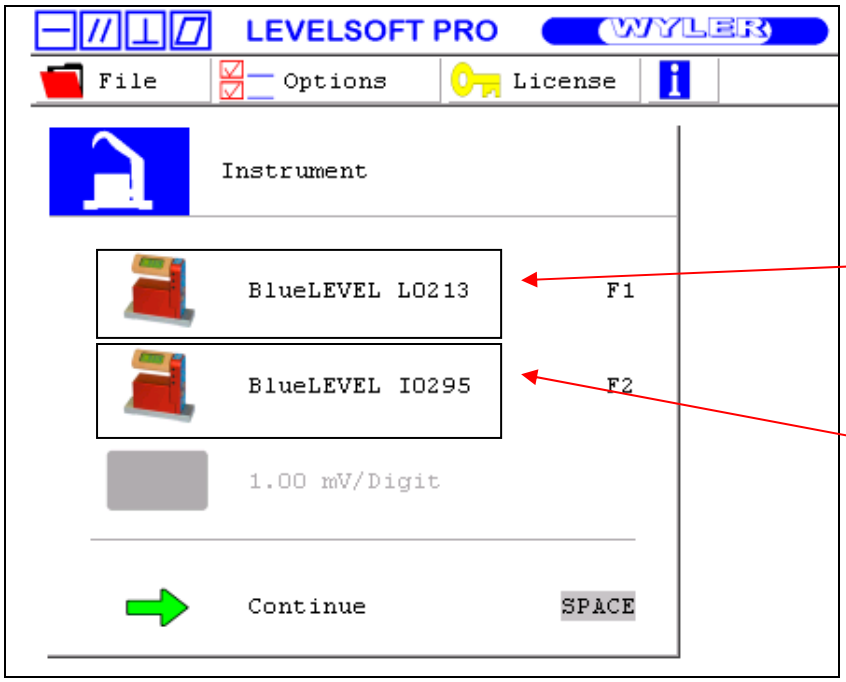
- **Correction of angular error**
  A predefined value can be entered
- **Determined by measurement**
  The instrument's angular error will be determined from new by the two reversal measurements as described in our example.

In our example we chose <F2> DETERMINATE the **angular correction by reversal measurement**

Remarks: For determining the angular correction of the instrument's error a **high precision parallel block (quality 000)**, preferably granite with flat top, is required. If needed please contact your local WYLER distribution partner or WYLER SWITZERLAND directly.

ATTENTION: If the measuring of a rectangular object is planned with two instruments (measuring and reference instrument), the **determination of the angular error of the measuring instrument must be performed with one instrument only**, the measuring instrument featuring an angular base. Please assign the measuring instruments as measuring respectively reference instrument well from the beginning when setting up the measuring configuration.

The reference instrument is deactivated during the determination of the angular error.

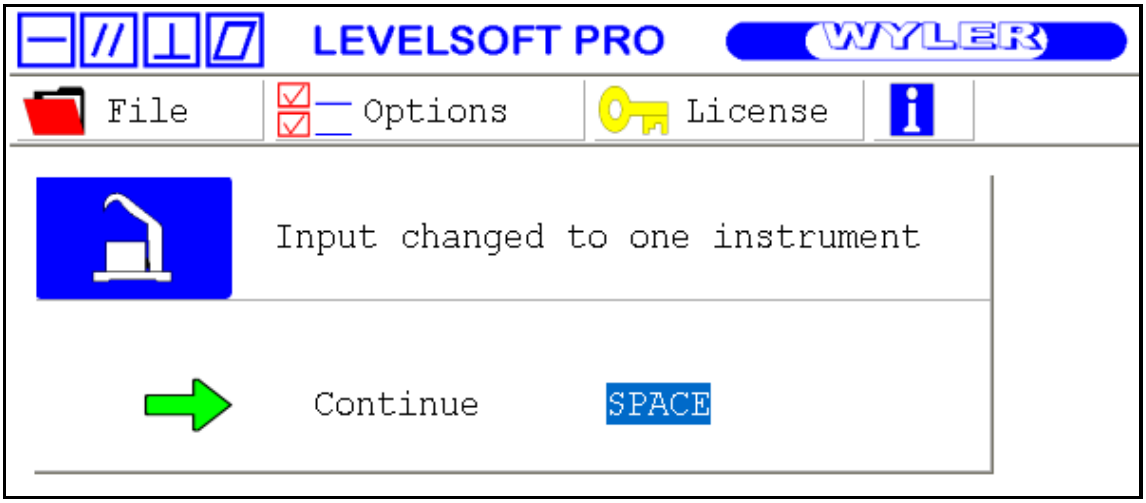


Definition of the measuring respectively reference instrument:

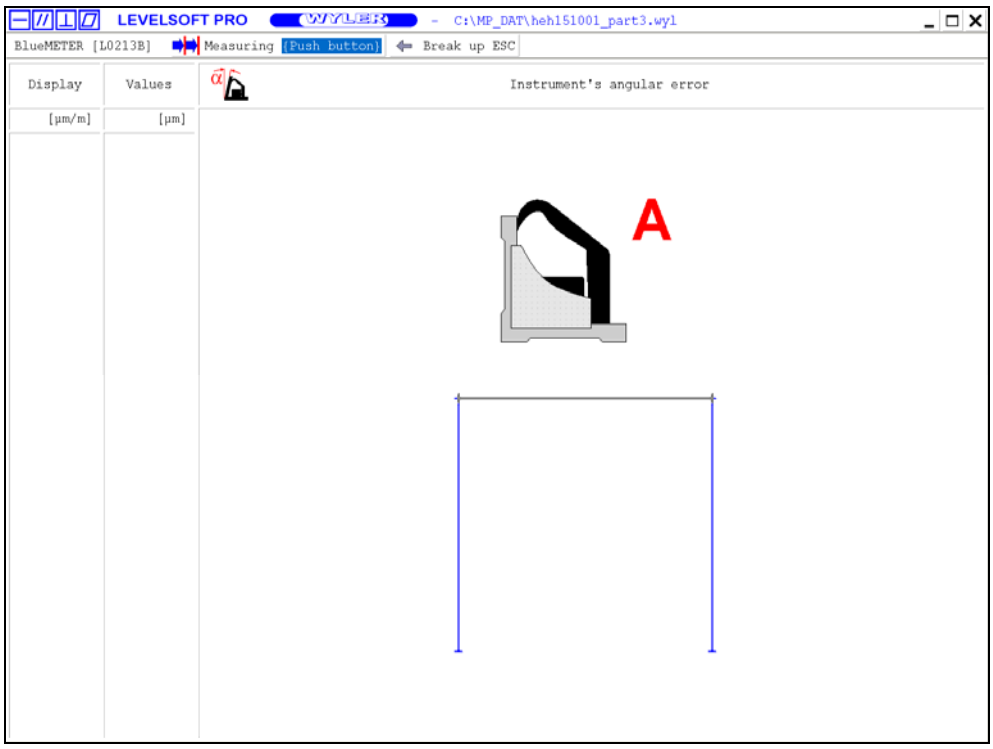
measuring instrument

reference instrument

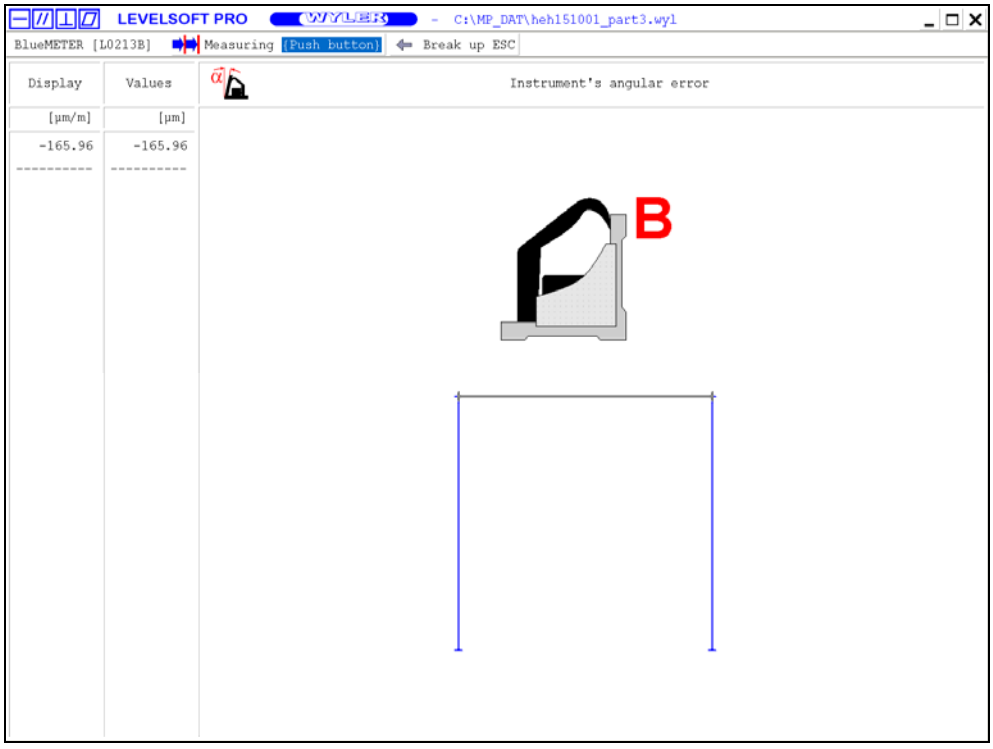
With [Continue] or [Space] the measurement will be started. The reading method only considers the measuring instrument, the reference instrument is deactivated.



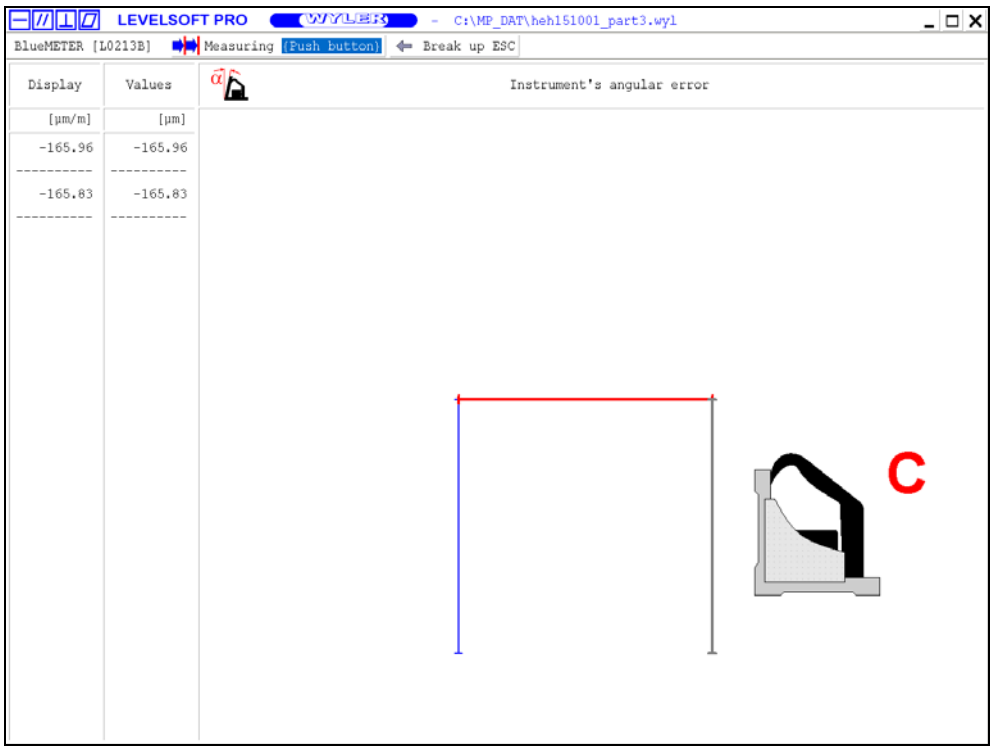
After that you perform the actual reversal measurement with the angular measuring instrument.



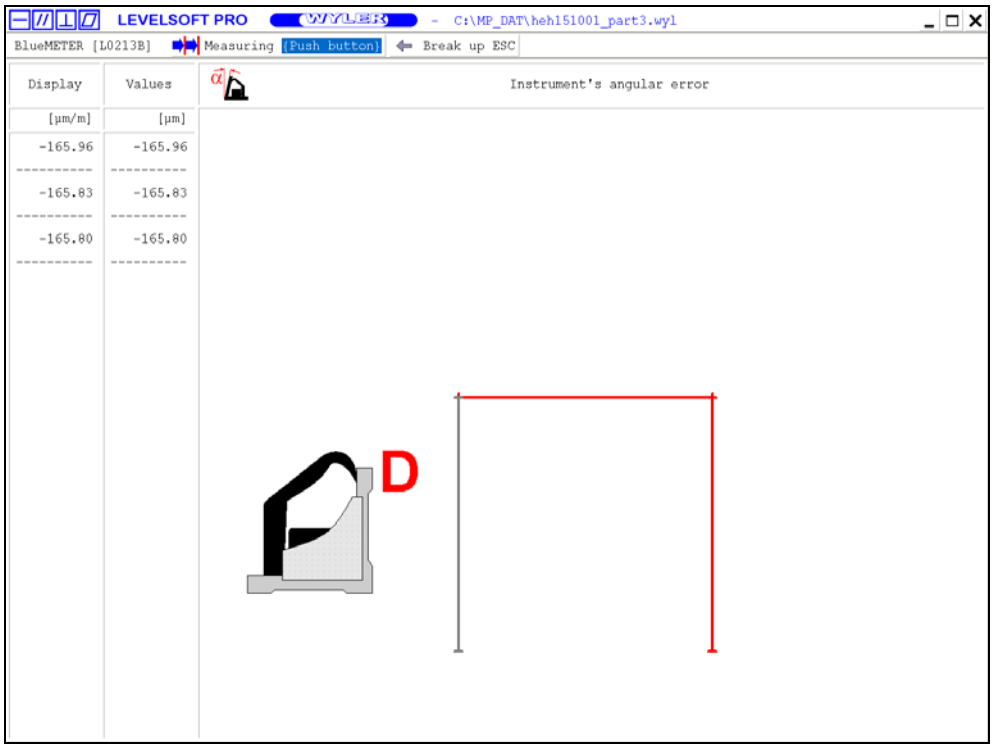
Value "A" is collected.



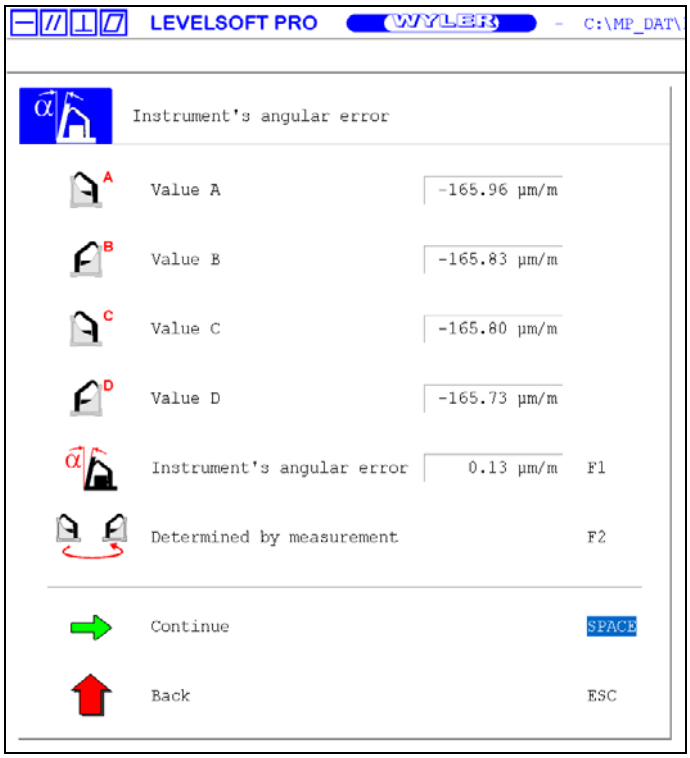
Value "B" is collected.



Value "C" is collected.



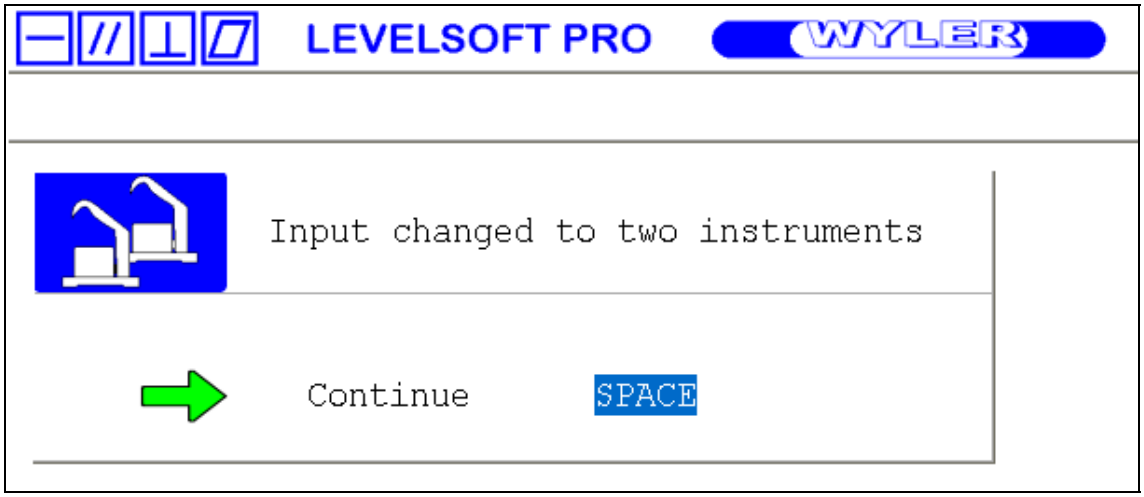
Value "D" is collected.



At the end of the reversal measurement the determined angular error as well as the individual values will be displayed

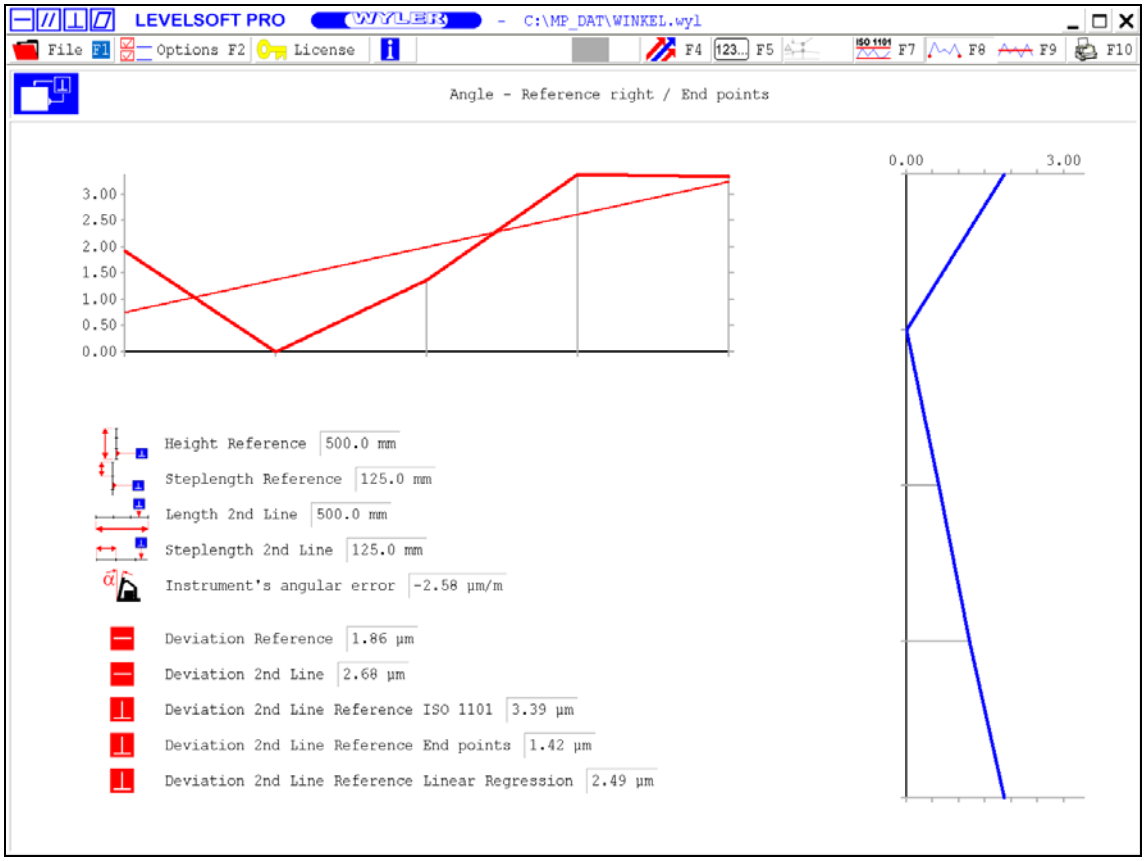
With <Continue> or the key [SPACE] the values will be incorporated in the measurement to follow.

To continue the display shows that the two instruments are activated for differential measurement again.



The display makes you aware that for the following measurement the reference instrument will be activated again and you can now start the actual measurement.

At the end of the measurement the result is displayed



In the first display of our example the **reference line (vertical line) is aligned according the method "Endpoints"**

The max. error of the reference line is 1,86 µm.

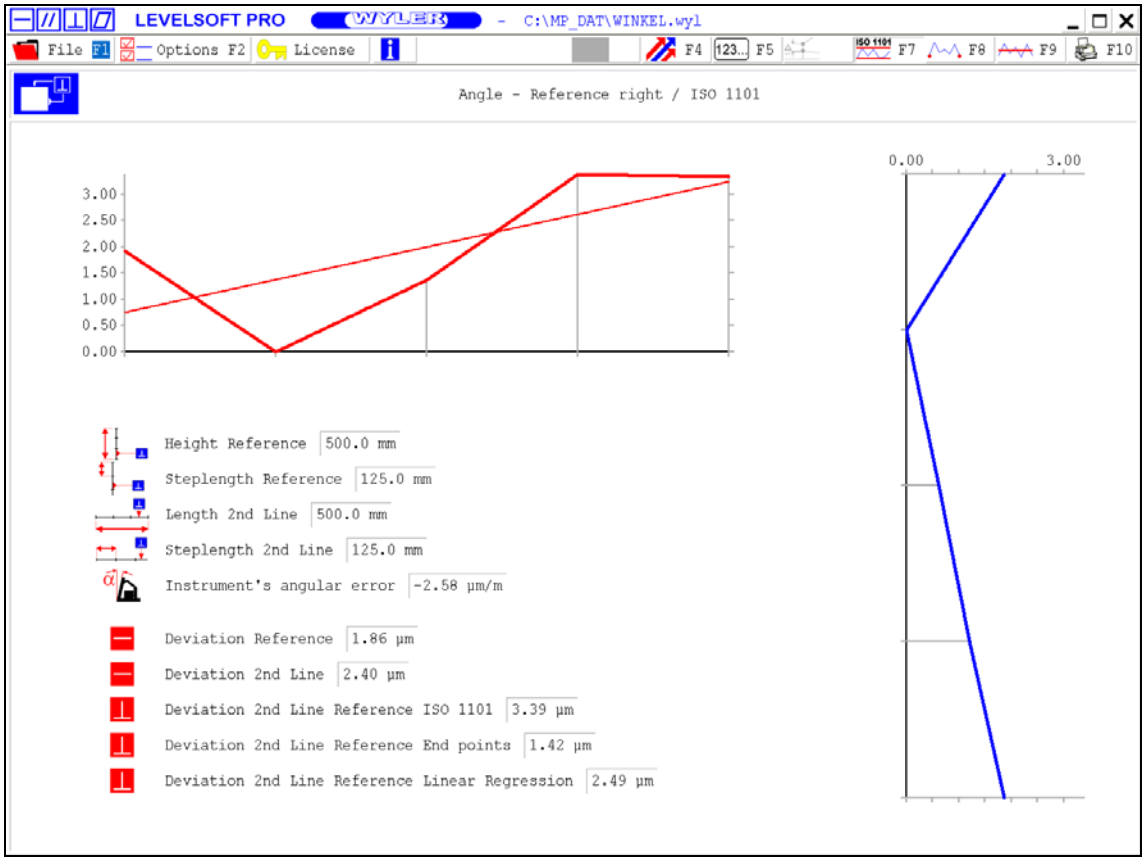
The **error of the second line is the maximum angular error of the whole object**. Depending on the different method of alignment this angular error may vary.

Maximum error related to reference line

- Alignment according to the **method "ISO 1101"** 3,4 µm
- Alignment according to the **method "Endpoints"** 1,4 µm
- Alignment according to the **method "linear Regression"** 2,5 µm

The following information is seen:

- Graph: Flatness of the measured object in graphical form
- Height (Length) reference: Total height of the measured reference line
- Step length reference line: Step length of the reference line
- Length second line: Total length of the second line
- Step length 2nd line: Step length of the second line
- Angular error of instrument: The correction of the instrument's angular error
- Error reference: Straightness error of the reference line
- Error 2nd line: Straightness error of the 2nd line
- Error 2nd line to reference ISO1101 Squareness error according to ISO1101 method
- Error 2nd line to reference END POINTS: Squareness error according to END POINTS method
- Error 2nd line to reference LINEAR REGR: Squareness error according to Linear regression method



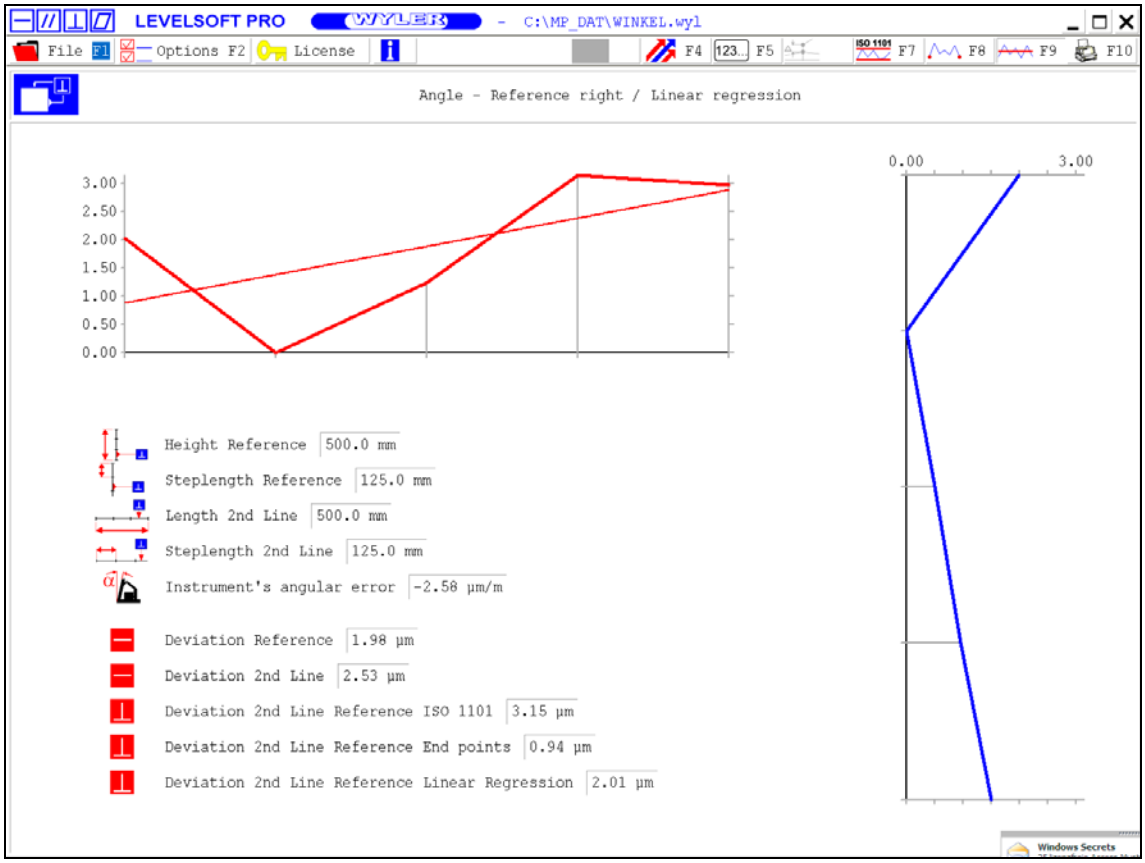
In the second display of our example the **reference line (vertical line) is aligned according the method ISO 1101**

The max. error of the reference line is 1,9 µm.

The **error of the second line is the maximum angular error of the whole object**. Depending on the different method of alignment this angular error may vary.

Maximum error related to reference line

- Alignment according to the **method "ISO 1101"** 3,4 µm
- Alignment according to the **method "Endpoints"** 1,4 µm
- Alignment according to the **method "linear Regression"** 2,5 µm



In the third display of our example the **reference line (vertical line) is aligned according the method *linear regression".**

The max. error of the reference line is 2,0 µm.

The **error of the second line is the maximum angular error of the whole object**. Depending on the different method of alignment this angular error may vary.

Maximum error related to reference line

- Alignment according to the **method "ISO 1101"** 3,1 µm
- Alignment according to the **method "Endpoints"** 0,9 µm
- Alignment according to the **method "linear Regression"** 2,0 µm

Summary

Alignment method reference	Deviation reference	Deviation 2nd Line	Angular error according to the method		
			ISO 1101	Endpoints	Linear Regression
Endpoints	1,9 µm	2,7 µm	3,4 µm	1,4 µm	2,5 µm
ISO 1101	1,9 µm	2,4 µm	3,4 µm	1,4 µm	2,5 µm
Linear Regression	2,0 µm	2,5 µm	3,1 µm	0,9 µm	2,0 µm

REMARK:
The user must judge which of the different methods is most suitable for the measuring task. Additional information on the subject of alignment of complex objects is described below.

The following steps

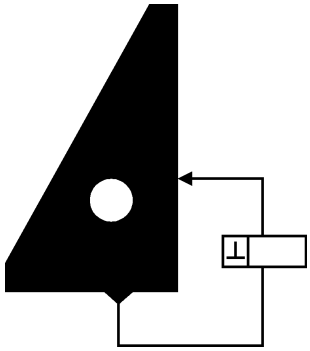
- Switch between graphical display and measuring pattern [F4]
- Display measured values [F5]
- Printing

are identical to the measurement of a line.

5.8 MEASUREMENT OF THE SQUARENESS OF A GRANITE MASTER SQUARE

Measuring task: **Measurement of the squareness of a granite master square with previous determination of the instrument's angular error by using a granite parallel block in quality 000.**
Procedure as per WYLER / SCS standard

A detailed calibration procedure is available upon request for this standard procedure, developed by WYLER AG and accredited by the Swiss Accreditation Service.
Such a calibration procedure will be supplied at a nominal charge.



Remarks:
The calibration procedure mentioned is especially for the squareness measurement of different objects, mainly for master squares (WYLER Standard delivery programme) and similar objects.

Requirements:

- Accessories
  - Granite surface plate / the flatness of the reference surface must be better than 50% of the expected angular error
  - Master granite parallel block (Quality 000)
  - The reference surface of the square to be measured must be concave, this means the master square to be measured must have the contact points close to the end of the reference surface.
- Environmental conditions
  - Climate controlled measuring laboratory
  - The measuring instruments as well as the object to be measured must have been for at least two hours in the laboratory for proper acclimatization.

Restrictions:

- The procedure is only acceptable for objects with surfaces min. 50 mm wide
- If the angular error is more than 2 µm/m, then the allowable error of each of the surfaces of the square must be less than 60% of the angular error.
- The max. angular error must be less than +/- 100 µm/m

Principle of the measurement

- The flatness of both surfaces of the object enclosing the 90 degree angle must be measured according the standard calibration procedure WYLER "SCS_03.doc"
- The angular error of the measuring instrument must be determined according to the calibration procedure "SCS_WI1.doc"
- Measurement of the 90 degree angle of the master square and computing the angular error considering the calibration procedure "SCS_WI2.doc", the definition of the angular error is done according to ISO 1101.

In the following example the procedure is explained in detail.

General procedure of the measurement

- The existing angular error of the measuring instrument is to determine by using a master granite square (this is not a must)
- After this the actual measurement is done according to the requirements in different steps as described below.

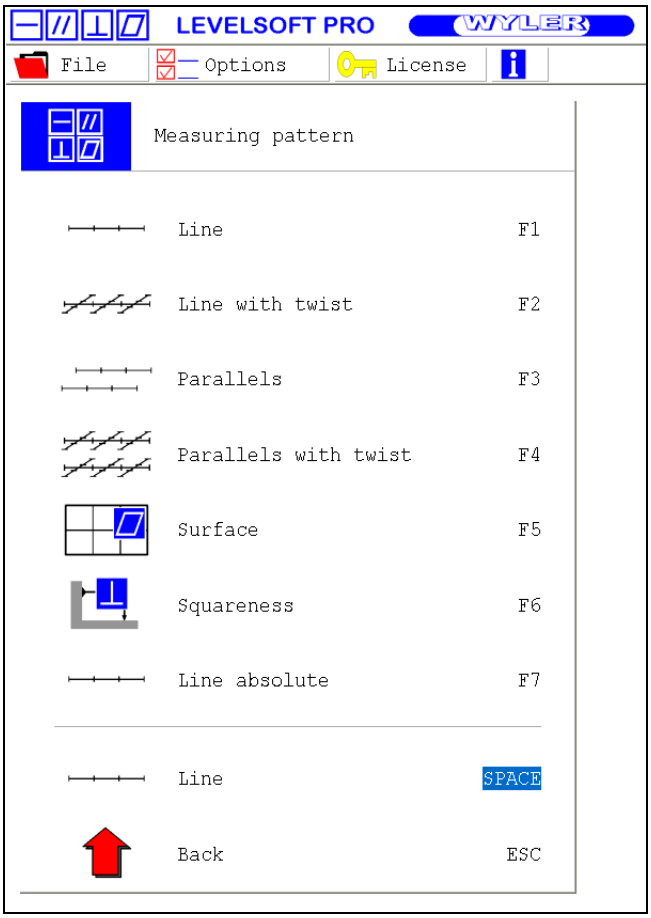
The measurement of the reference line is done according to the END POINT method.
After the measurement is done different possibilities exist for the alignment of the second line. The result of the measurement is displayed will show three possible values depending on the alignment method chosen:

- Alignment according to the method “Endpoints”
- Alignment according to the method “ISO 1101”
- Alignment according to the method “linear Regression”

Example:
Measuring task: **Measuring of a master square 500 x 315 mm**
The angular error of the instrument must be determined before the measurement and incorporated in the measurement

- 2 measuring instruments are connected via BlueMETER to a PC
- Object: Squareness SCS WYLER
- Step length reference: 125 mm (horizontal)
- Step length 2nd line 105 mm (vertical line)
- Number of measurements reference line 3 (horizontal)
- Number of measurements 2nd line 4 (vertical)
- Base length of the instrument 150 mm

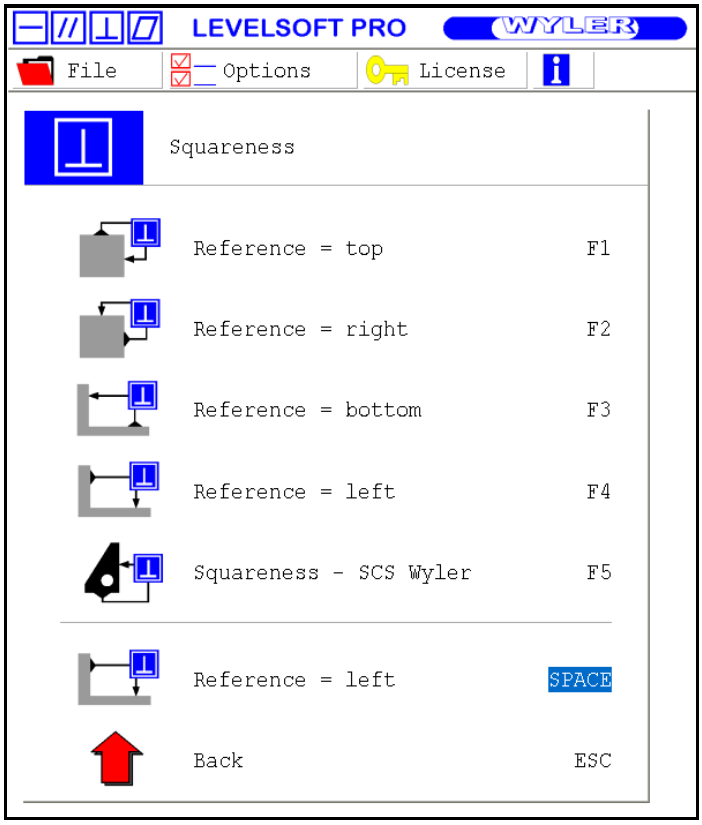
Start measurement, with/without saving the measuring pattern is identical to measuring a line



The following dialogue box is seen with the listing of the possibilities of the objects:

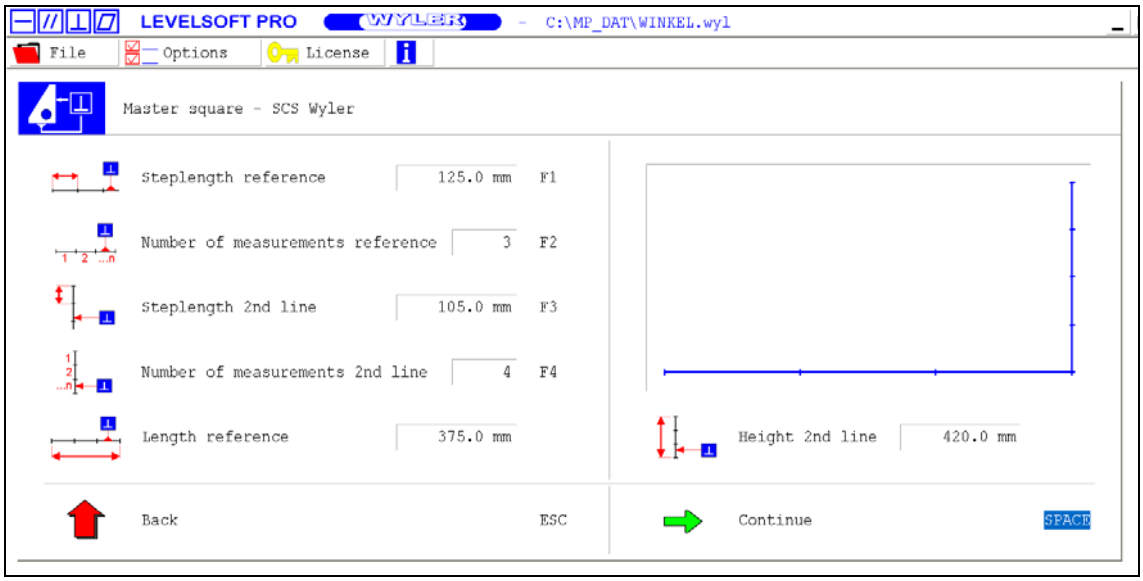
- **LINE**
  Measurement of lines
- **LINE WITH TWIST**
  Measurement of lines with twist
- **PARALLELS**
  Measurement of up to 3 parallels
- **PARALLELS WITH TWIST**
  Measurement of up to 3 parallels with twist
- **SURFACE (Flatness)**
  Measurement of surfaces, respectively flatness
- **SQUARENESS (Measurement of right angle)** Measurement of 90 deg. Angles
- **LINE ABSOLUTE**
  Measurement of a line with absolute values

In our example chose now <SQUARENESS> / [F6]



In our example chose now
<SQUARENESS – SCS WYLER> / [F5]

The mask for entering the parameters is displayed.



The following parameters must be entered now:

- Step length reference: 125mm
- Number of measurements reference 3
- Step length 2nd line 105mm
- Number of measurements 2nd line: 4

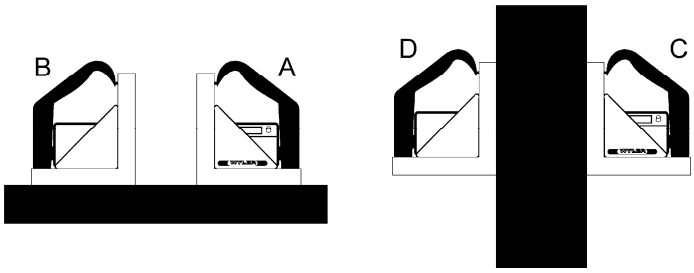
The data is displayed in the monitor (top right) and can be accepted with <Continue> / [SPACE]

The other steps

- Way of measuring
- Limit of variation
- Surveillance of drift
- Start measurement, with/without saving the measuring pattern

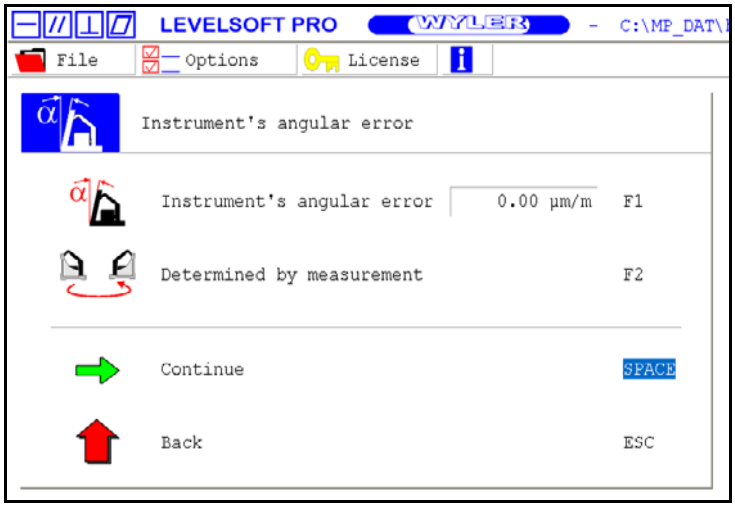
are identical to measuring a line

The next step is the determination of **the instrument's error** which is done by two reversal measurements (horizontal and vertical) according to the sketch below.



Calculation of the index of correction, respectively
the angular error of the instrument

$$\text{Index of correction} = \frac{C + D}{2} - \frac{A + B}{2}$$



Two options exist:

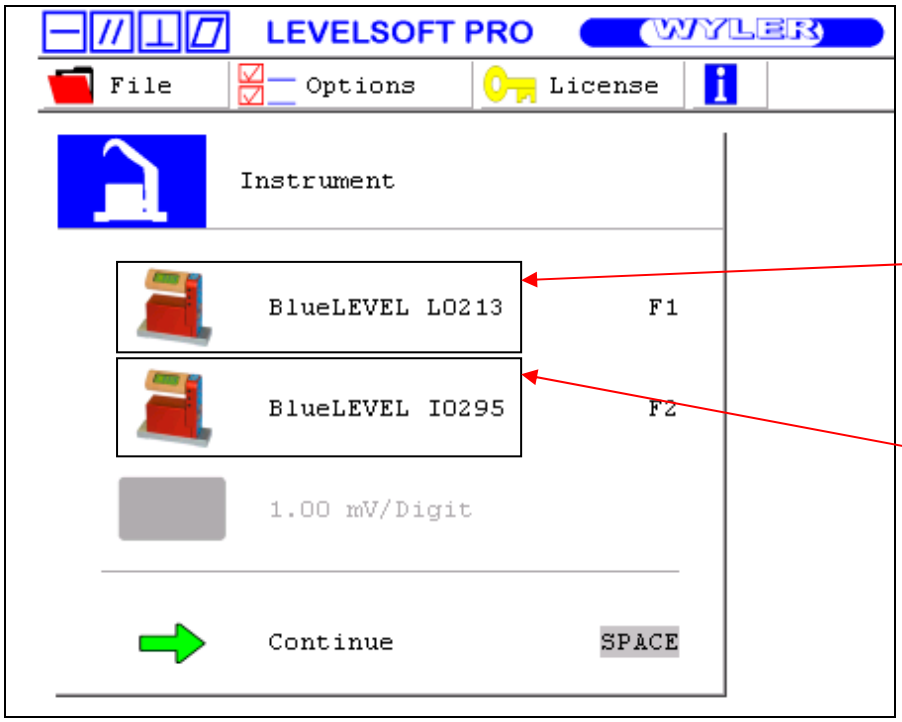
- **Enter the angular error**
  A predefined value can be entered
- **Determined by measurement**
  The instrument's angular error will be determined from new by the two reversal measurements as described in our example.

In our example we chose [F2] DETERMINE the **angular correction by reversal measurement**

Remarks: For determining the angular correction of the instrument's error a **high precision parallel block (quality 000)**, preferably granite with flat top, is required. If required please contact your local WYLER partner or WYLER SWITZERLAND directly.

ATTENTION: If the measuring of a rectangular object is planned with two instruments (measuring and reference instrument), the **determination of the angular error of the measuring instrument must be performed with one instrument only**, the measuring instrument featuring an angular base. Please assign the measuring instruments as measuring respectively reference instrument well from the beginning when setting up the measuring configuration.

The reference instrument is deactivated during the determination of the angular error.

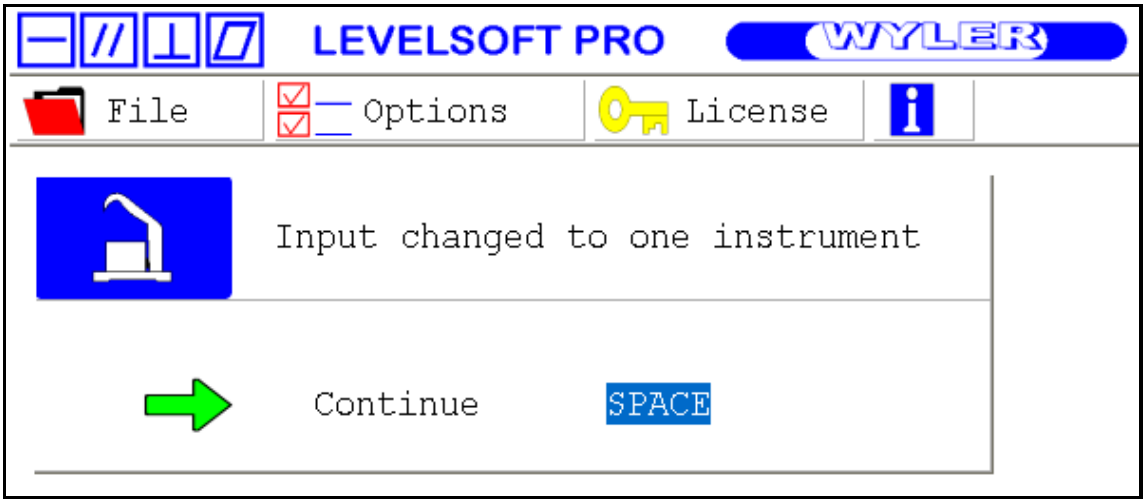


Definition of the measuring respectively reference instrument:

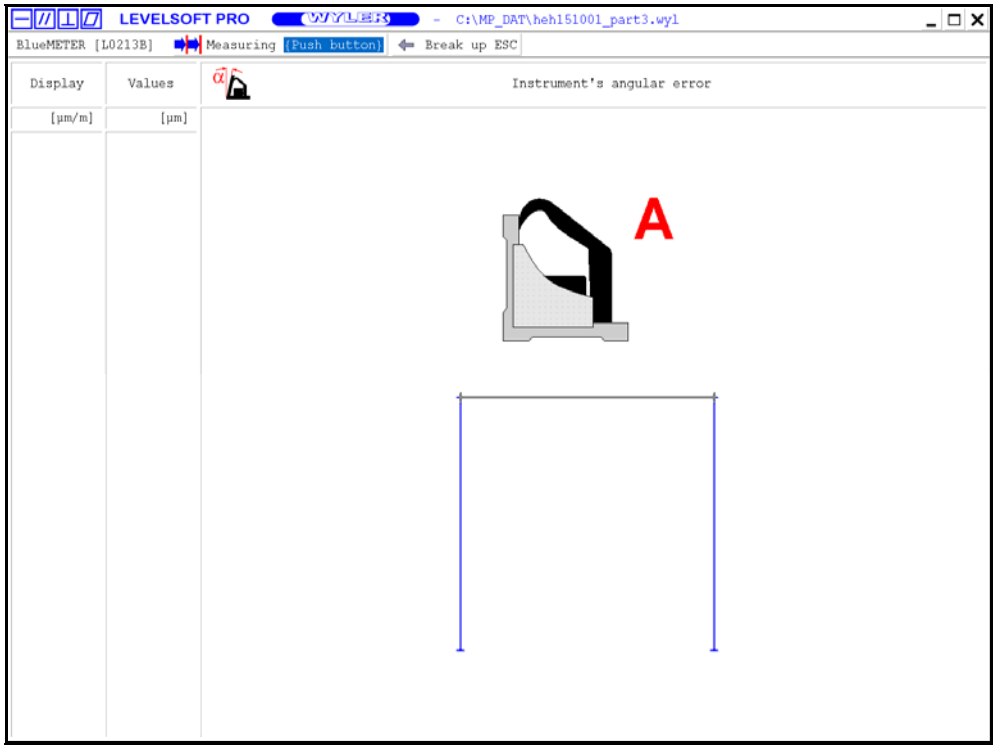
measuring instrument

reference instrument

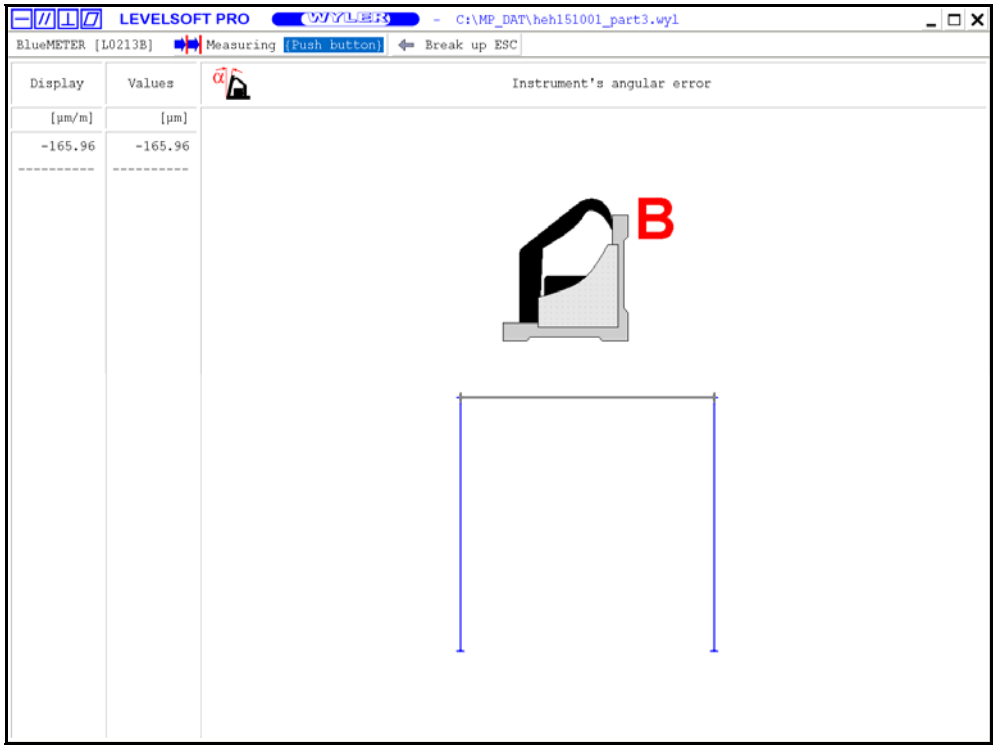
With [Continue] or [Space] the measurement will be started. The reading method only considers the measuring instrument, the reference instrument is deactivated.



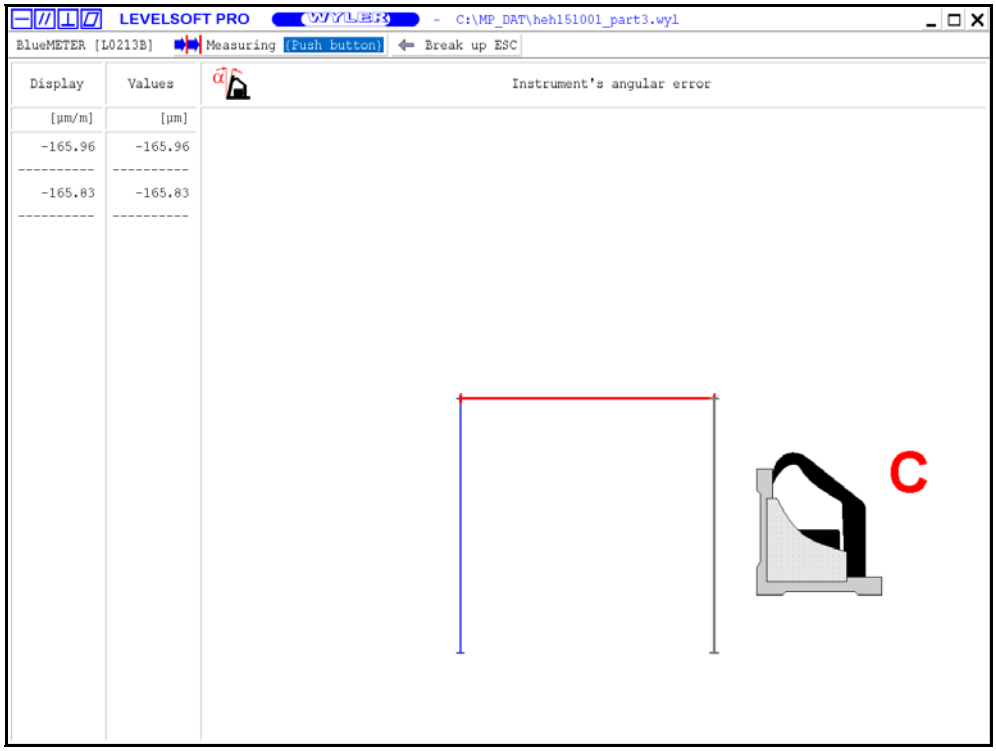
After that you perform the actual reversal measurement with the angular measuring instrument.



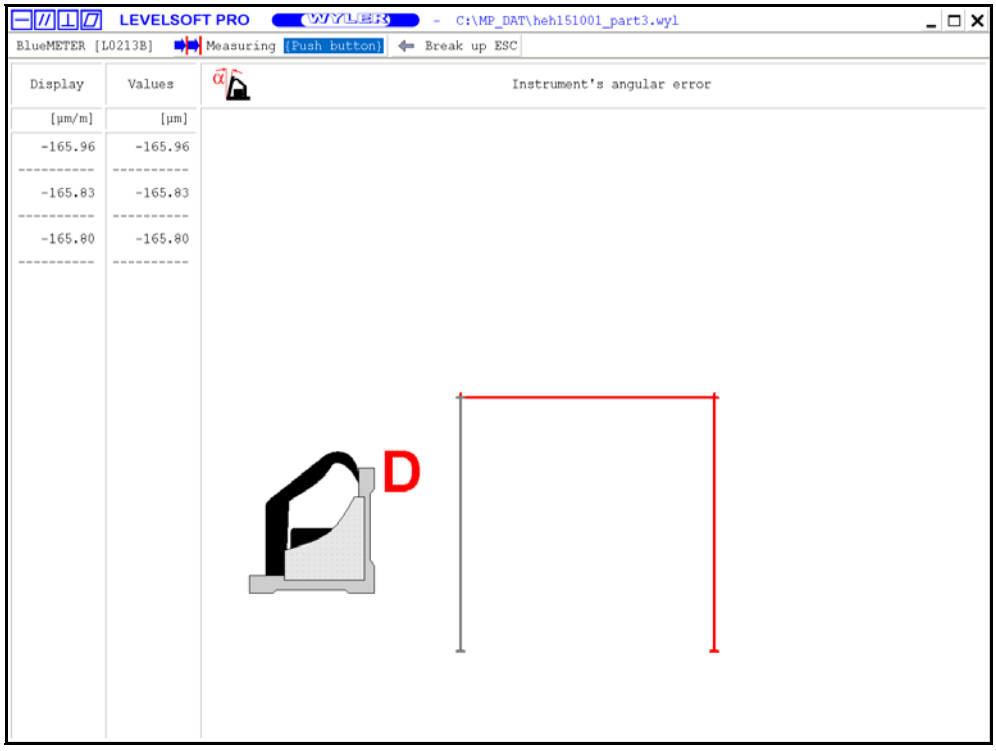
Value "A" is collected.



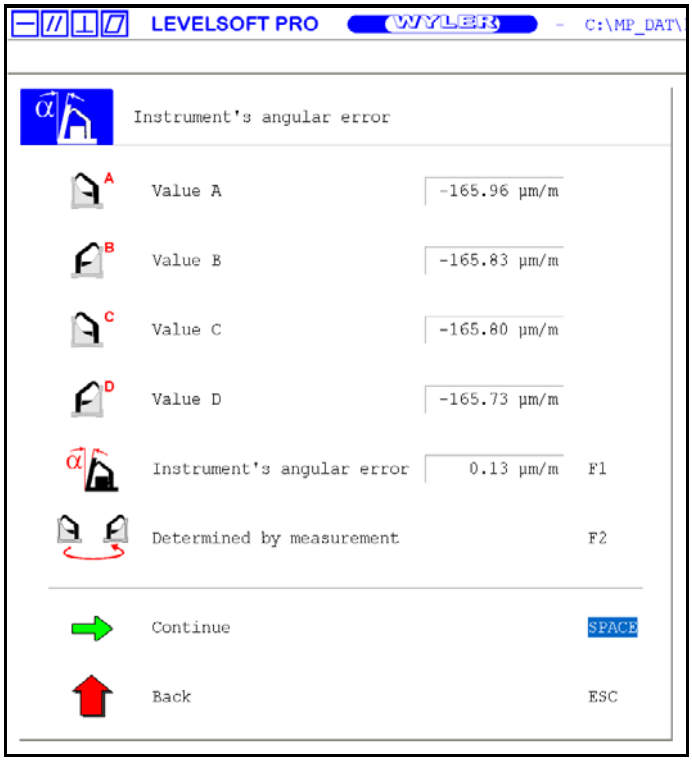
Value "B" is collected.



Value "C" is collected.



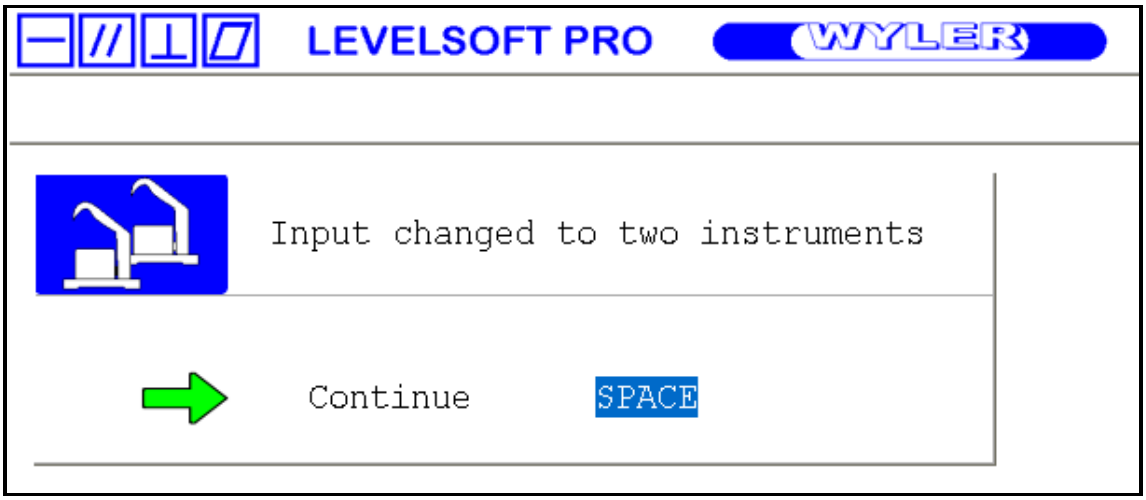
Value "D" is collected.



At the end of the reversal measurement the determined angular error as well as the individual values will be displayed

With <Continue> or the key [SPACE] the values will be incorporated in the measurement to follow.

To continue the display shows that the two instruments are activated for differential measurement again.

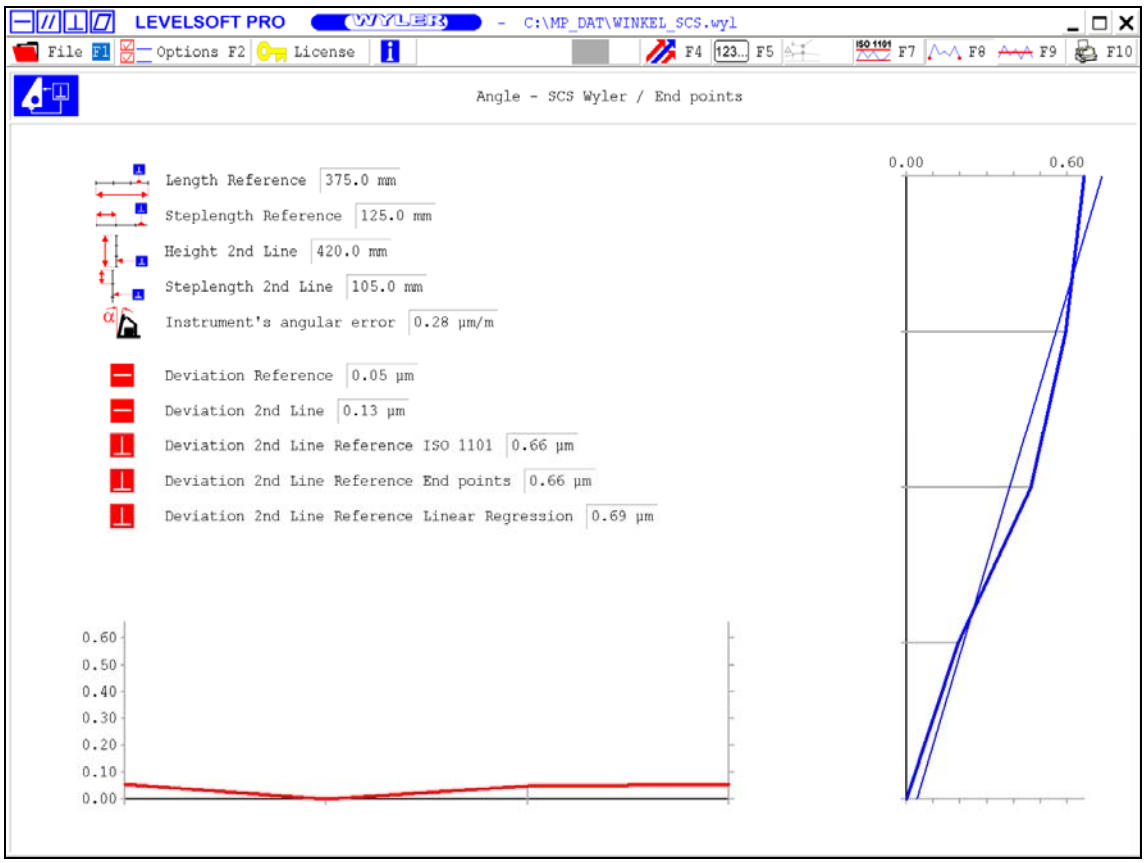


The display makes you aware that for the following measurement the reference instrument will be activated again and you can now start the actual measurement.

Important remark:

For master squares planned to be used mainly in "upright" position on a reference surface the measurement of one side can be done on a defined reference area of a surface plate.
The flatness of this reference area must be better than 50% of the expected angular error.
It is important that the contact points of the master square to be measured must be close to the end of the reference side (defined support).

At the end of the measurement the result is displayed



Contrary to the other measurements of 90 degree angles the alignment method used for the **reference line of the master squares** is exclusively according to **“ENDPOINTS”**. The mayor reason being the fact that the reference line is required to be concave. Therefore the results would be the same no matter what alignment chosen.

The error of the reference line is 0.05 µm

The angular error of the second line is displayed in 3 different ways. Thereby please be aware that in case of the SCS calibration the alignment method used is according to ISO 1101 or according to the method “Endpoints”. The error according to "linear regression" is for information purposes only.

Maximum Error second Line according to

- the **method ISO1101** 0.66 µm
- the **method "Endpoints"** 0.66 µm

For additional information a third alignment method is displayed.

- Alignment according to the **method "linear Regression”** 0.69 µm

The following information is seen:

- Graph: Flatness of the measured object in graphical form
- Length reference Length of the reference line of the object
- Step length reference line: Step length of the reference line
- Height 2nd line: Total height/length of the second line
- Step length 2nd line: Step length of the second line
- Angular error of instrument: The correction of the instrument’s angular error
- Error reference: Straightness error of the reference line
- Error 2nd line: Straightness error of the 2nd line
- Error 2nd line to reference ISO1101 Squareness error according to ISO1101 method
- Error 2nd line to reference END POINTS: Squareness error according to END POINTS method
- Error 2nd line to reference LINEAR REGR: Squareness error according to Linear regression method

5.9 LINE ABSOLUTE / MEASUREMENT OF AN OBJECT WITH VALUES ABSOLUTE

Purpose of this measurement:
The intention is to use a suitable measurement for setup an object to a horizontal position, respectively to define the actual position of an object in the space.
In order to do so a line is to be measured with absolute values determined. (Absolute in relation to the centre of the earth). After the measurement the object is to be aligned according to the endpoint method to setup horizontally.

5.9.1 Measurement with Mini T/C without radio transmission, by means of cable connection

(Using T/C with radio transmission see pt. 5.9.2)

Example:
Measuring an object of 2100 mm length / measurement with one instrument

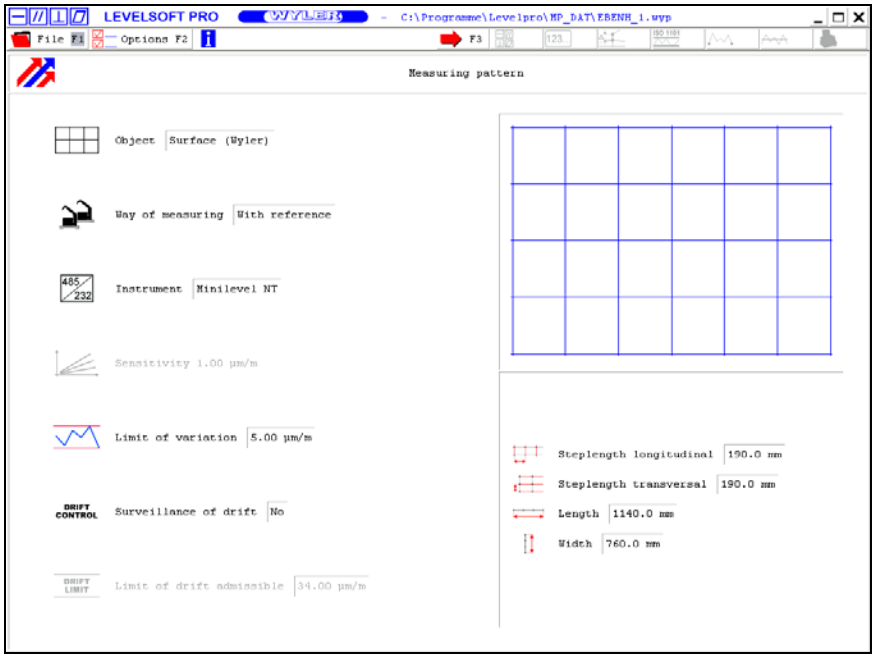
- The instrument is connected to a Mini T/C with cables and from there to a PC
- Number of measurement: 16
- Points for adjustment: Measurement 4 + Measurement 12
- Base length instruments: 150mm
- Step length: 125mm

IMPORTANT:
When measuring a LINE ABSOLUTE the following points must be regarded:

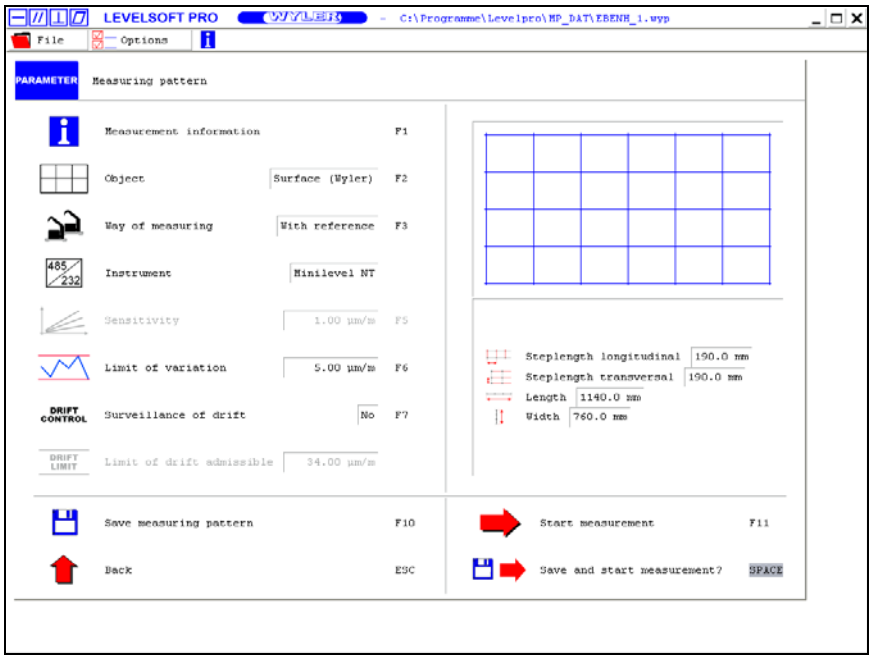
- The measurement can only be done **with one instrument**, (no differential measurement)
- The interface between the measuring instrument and the PC must be one of the following:
  - BlueMETER or BlueMETER BASIC with/without radio module, communication required in both directions
  - Levelmeter 2000 with/without radio module, communication required in both directions
  - Mini T/C (Mini Transceiver/Converter) with/without radio module

Configuration of software LEVELSOFT PRO:

After starting the software the following windows appears with the **last used measuring pattern**. In our example the flatness of an object was measured.



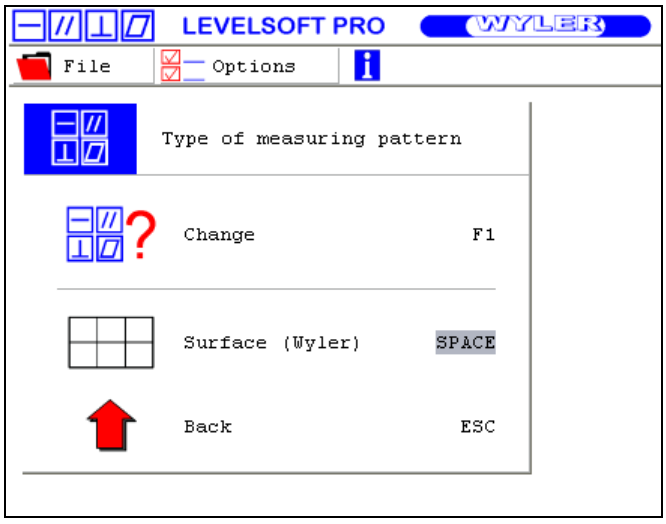
To setup the required measuring task open the menu point “File / Measuring pattern New / Change”.



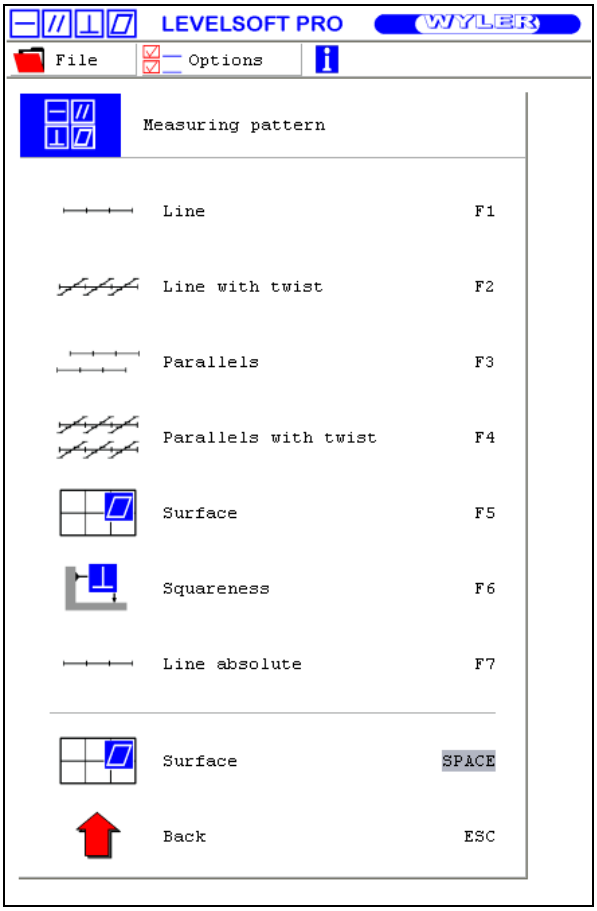
The different positions must be adjusted:

- Object
- Way of measuring
- Instrument, (LEVELMETER 2000 will automatically be recognised)
- Sensitivity, when using LEVELMETER2000, sensitivity will automatically be recognised and appears on the screen in a frame
- Limit of variation
- Surveillance of drift (For measuring LINE ABSOLUTE, **not possible**)
- Limit of drift admissible (Only when surveillance of drift is active)

As a first step the actual measuring object must be changed by a mouse click to "Object" or key [F1].



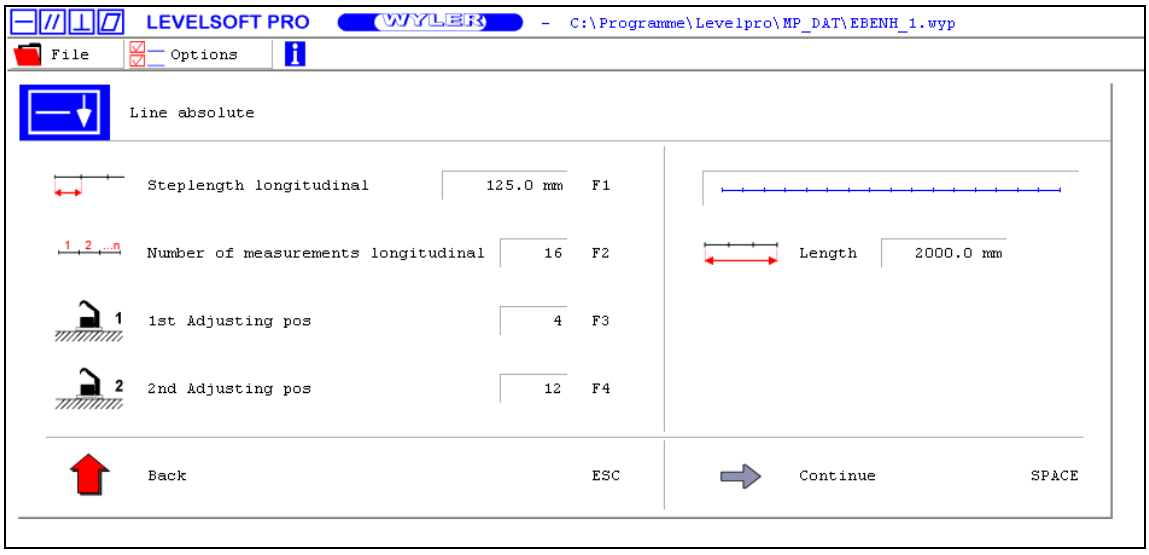
As a first step the actual measuring object (Surface WYLER) must be changed by mouse click to "Object" or key [F1].



The following dialogue box is seen with the listing of the possibilities of the objects:

- **LINE**
  Measurement of lines
- **LINE WITH TWIST**
  Measurement of lines with twist
- **PARALLELS**
  Measurement of up to 3 parallels
- **PARALLELS WITH TWIST**
  Measurement of up to 3 parallels with twist.
- **SURFACE (Flatness)**
  Measurement of surfaces, respectively flatness
- **SQUARENESS** (Measurement of right angle)
  Measurement of 90 deg. angles
- **LINE ABSOLUTE**
  Measurement of a line with absolute values

In our example we chose <LINE ABSOLUTE> / [F7]

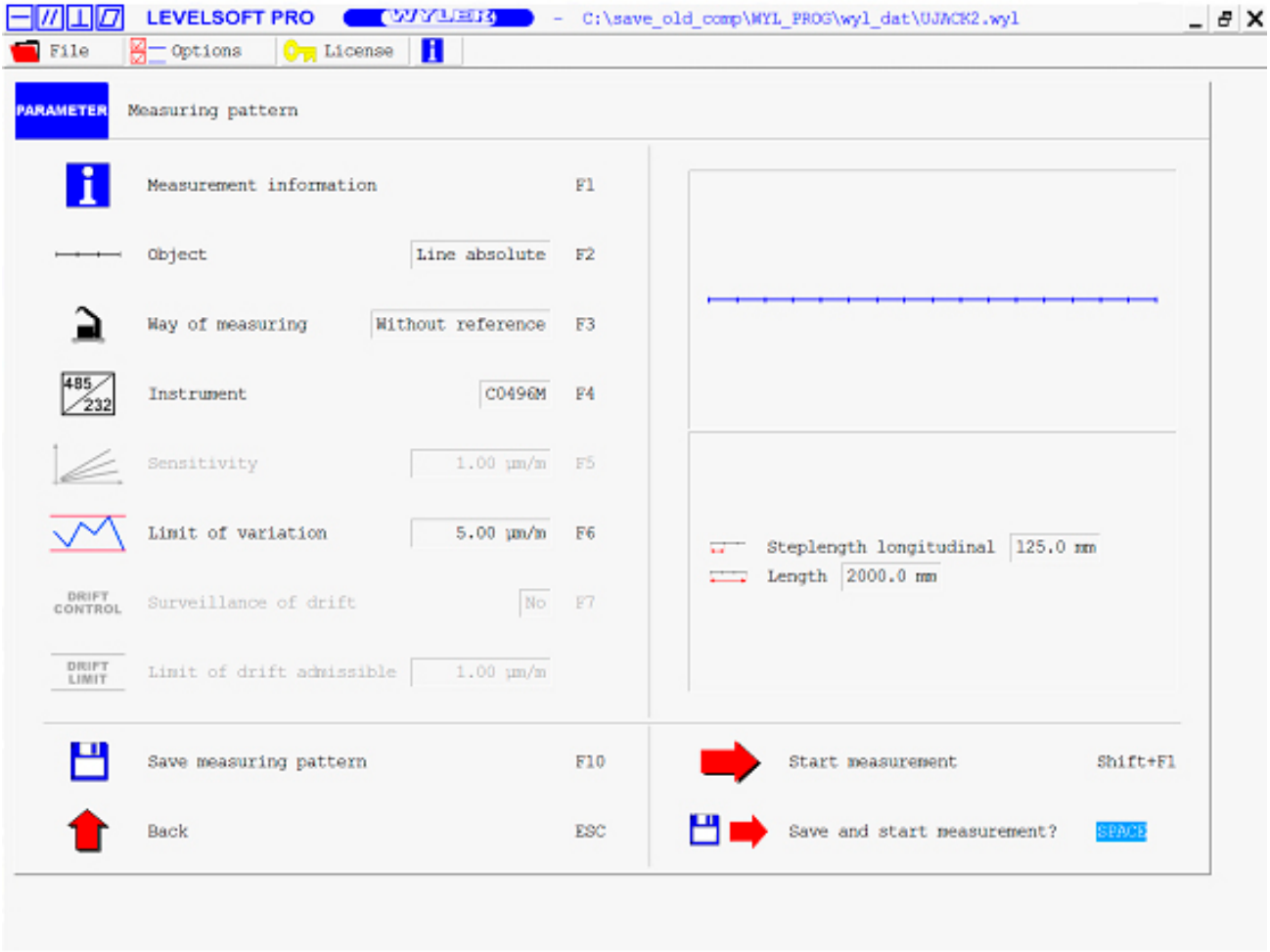


Enter now the parameters

- Step length: 125mm
- Number of measurements 16
- 1st adjusting pos.: 4 (1st position to adjust the object)
- 2nd adjusting pos.: 12 (2nd position to adjust the object)

The data is displayed in the monitor (top right) and can be accepted with <Continue> / [SPACE]

You return to the measuring pattern where the new set up is displayed
"Instrument [A]" is now set.



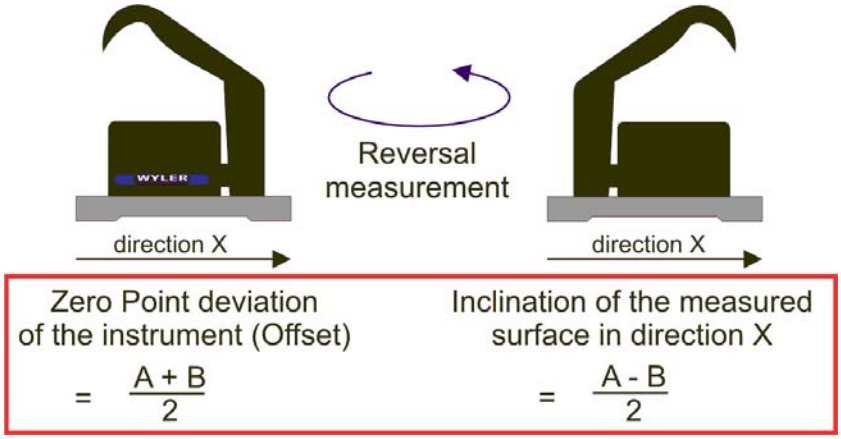
As "measuring instrument" the symbol of the LEVELMETER 2000 (Mini-T) with or without radio transmission as well as the serial number of the MINILEVEL NT connected.

As a next step the Limit of variation can be set.

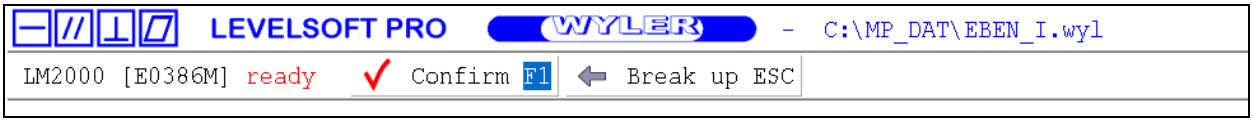
After defining this new configuration, respectively the new measuring pattern the following procedures are now possible:

- With <SAVE MEASURING PATTERN> [F10] you can save the configuration for later use as a measuring pattern without starting the actual measurement.
  Such a procedure makes sense when first a number of different patterns will be defined for later use.
- With <START MEASUREMENT> [F11] you start a measurement without saving as measuring pattern
- With <SAVE AND START MEASUREMENT> / [SPACE] you will be asked to save the configuration as a measuring pattern before starting the measurement

After starting the measurement <START MEASUREMENT> [F11] the **determination of the instrument's ZERO-OFFSET** is started. This determination is done by means of a reversal measurement. (See sketch below) Such a reversal measurement is best done on a horizontally adjusted surface plate

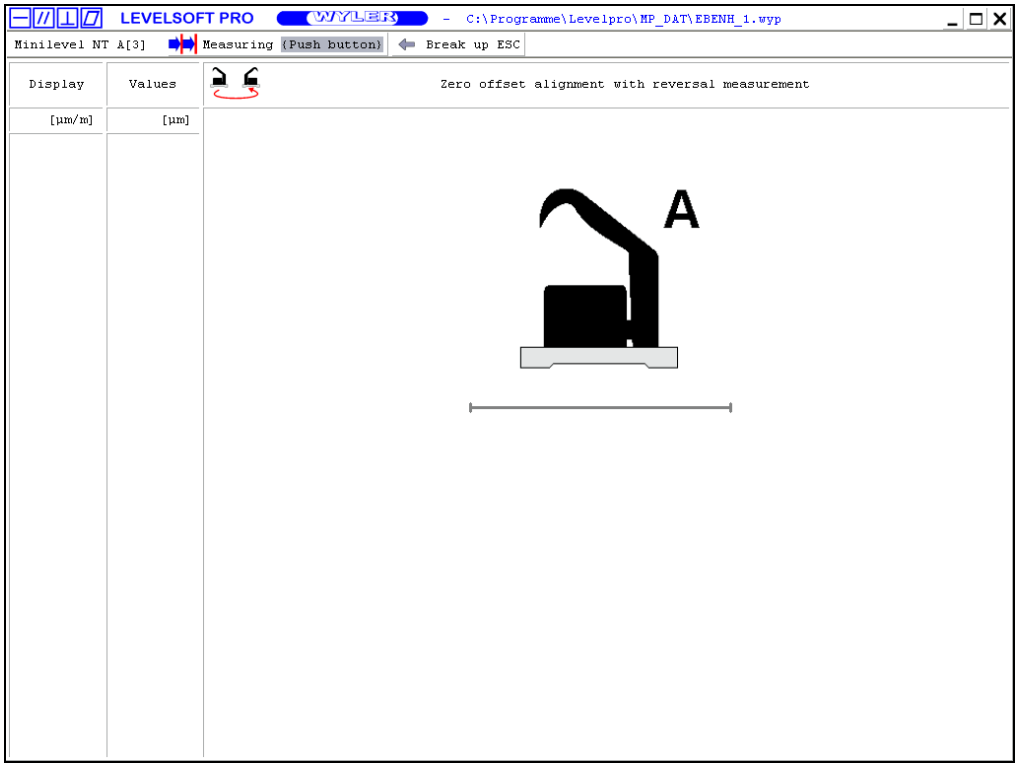


Before starting the reversal measurement the instrument must be correctly recognised, the address is to be carefully checked. In our case the address is "3". This is especially important, when using radio transmission.

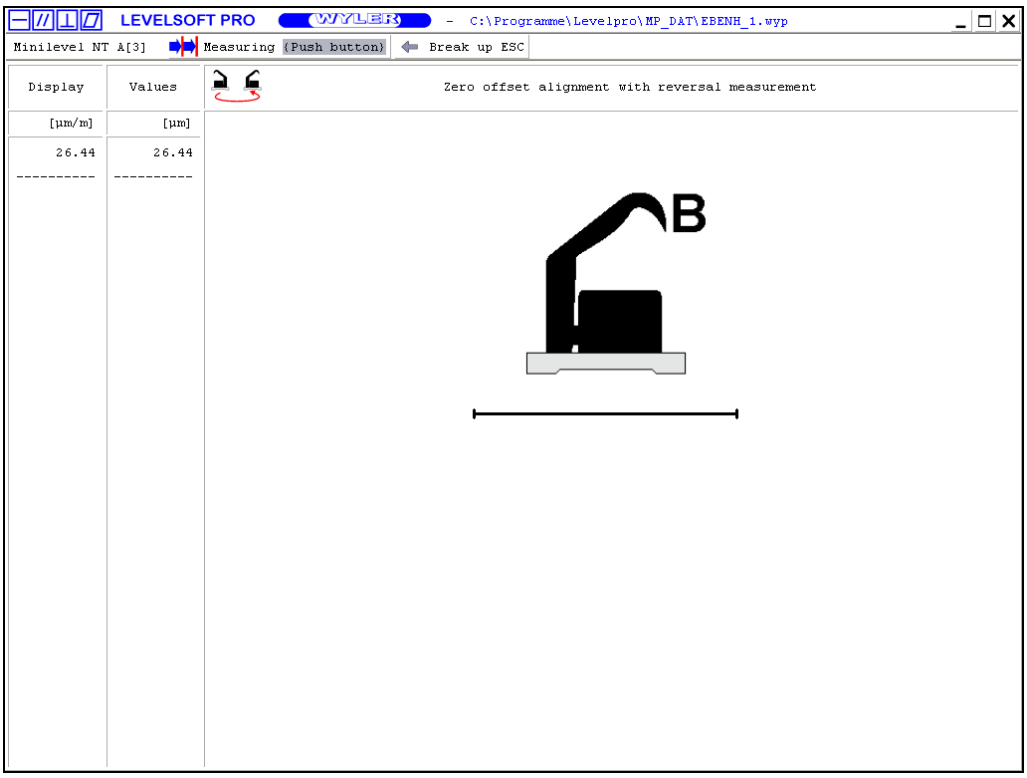


Confirm with [F1].

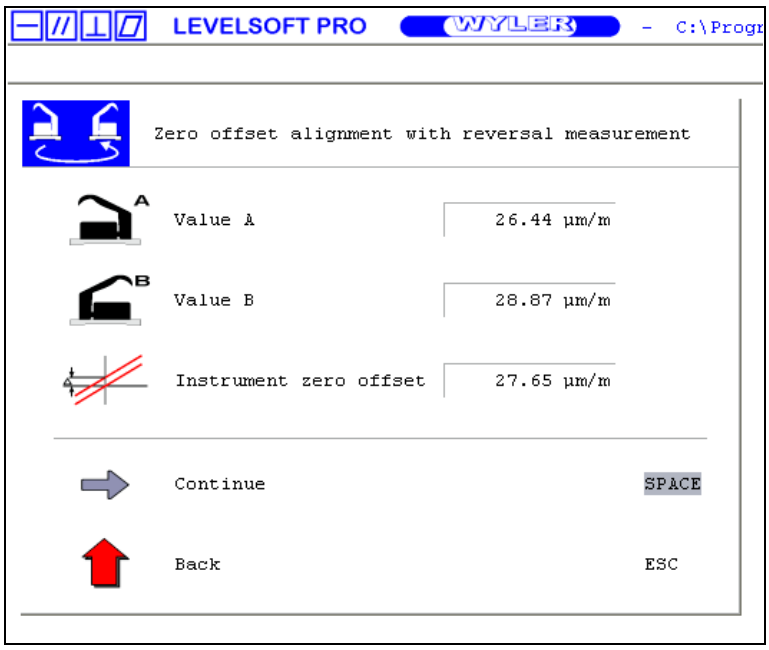
After this the actual reversal measurement can start.



Value "A" is collected.



Value "B" is collected.



At the end of the reversal measurement the determined angular error (ZERO-OFFSET) as well as the individual values will be displayed

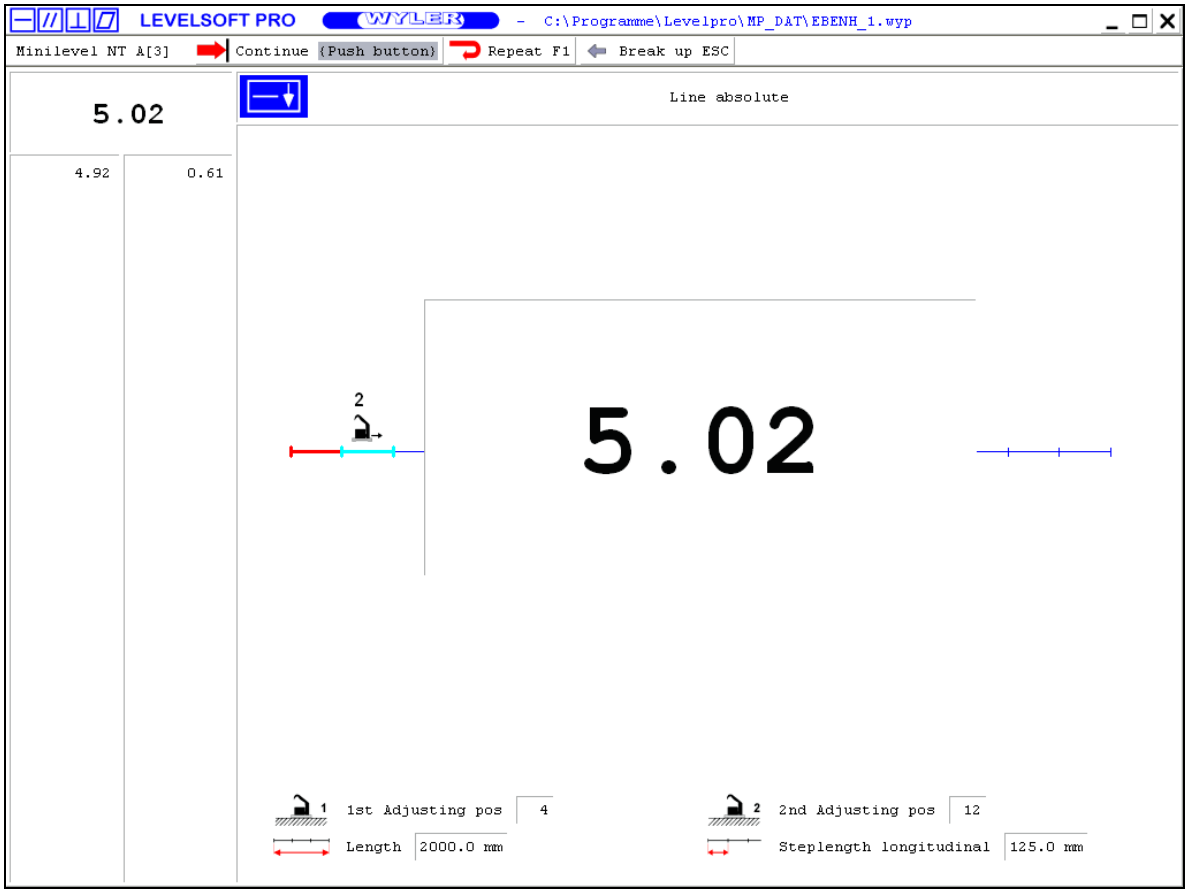
In case the values are reasonable the measurement can now be started by using <Continue> / [SPACE]

Remarks:
The defined **ZERO-OFFSET** (Zero offset of the instrument) is automatically stored in the instrument. This means that the instrument can be disconnected from the system and the instrument will display the correct measured values absolute.

In case the reversal measurement is not finished completely the “old” ZERO OFFSET remains in the instrument stored.

During the measurement the following information is displayed:

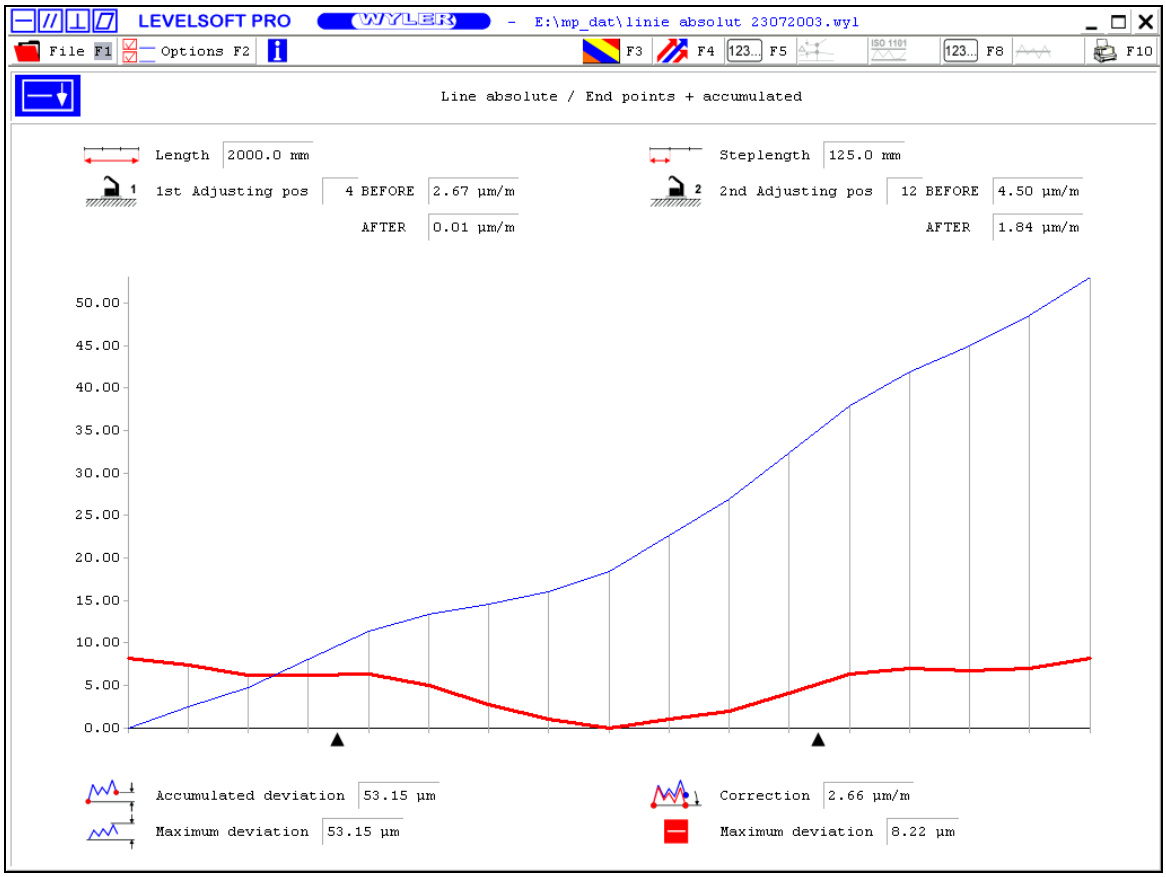
- Display: Values displayed on the instrument (Average value)
- Value The inclination calculated to step length
- Graph: Indicates where the instrument must be placed
- 1st adjusting pos.: 4 (1st position to adjust the object)
- 2nd adjusting pos.: 12 (2nd position to adjust the object)
- Length: Total length of the line to be measured
- Step length: The step length of each individual measurement



Repeat measurement:

- After the actual collecting of the measured the measurement can be repeated by using <REPEAT> / [F1]
- After confirming the latest individual measuring value it is possible to use <BACK> / [F2] and then all the values of the whole last measured line can be measured again.

After the last measurement has been taken automatically the following graph of the measured line is displayed in absolute mode as well as aligned according the endpoint method. (see below)

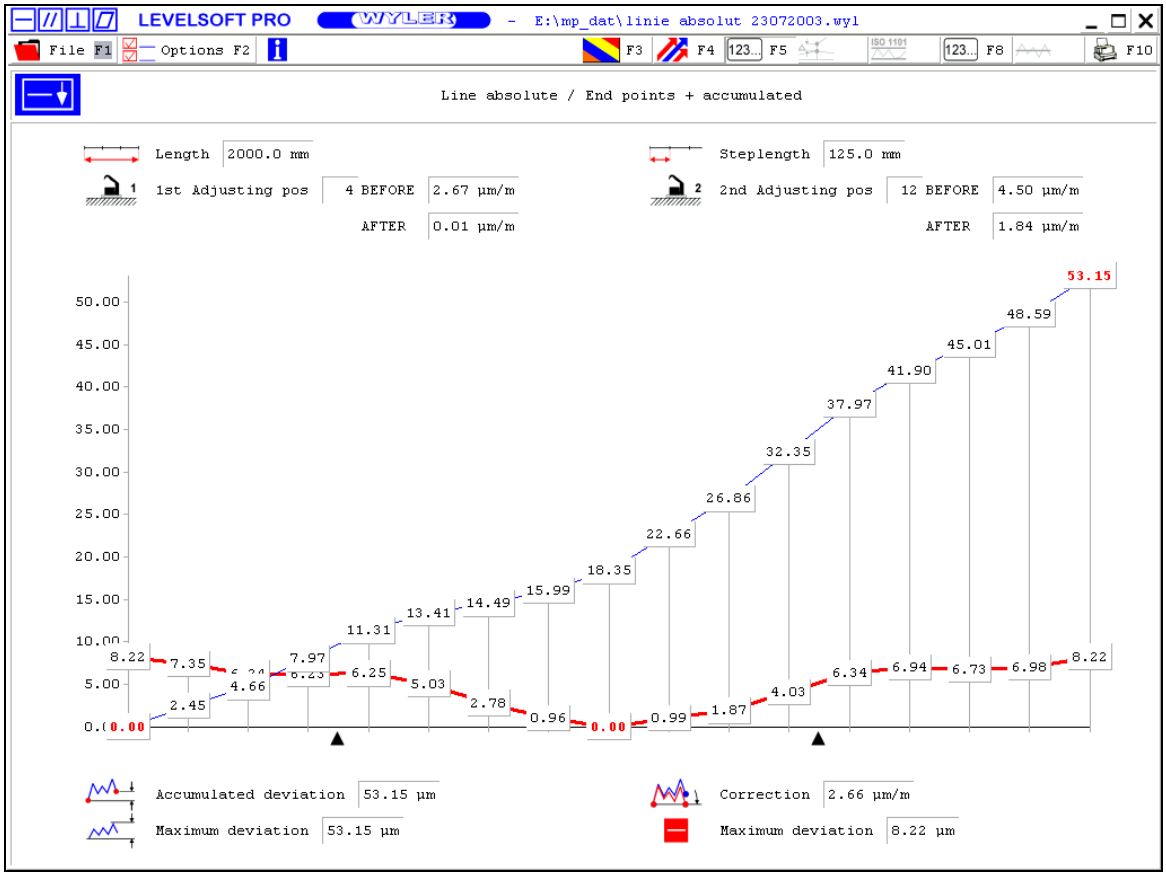


Using the key [F8] the lines can be displayed individually, with the key [F5] the individual numerical values can be displayed or deleted.

The following information is available on the monitor:

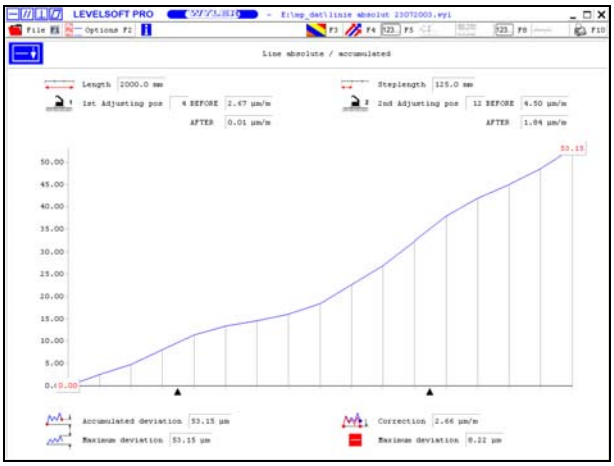
- Graph: Displays the straightness of the measured and the adjusted line in graphical form
- LINE ABSOLUTE / ENDPOINTS accumulated: Shows that the line is aligned according to the **endpoint method**.
- Length: Total length of the measured line
- Step length: The step length of each individual measurement
- 1st adjusting pos. BEFORE Value measured at the first adjusting position during measurement
- 1st adjusting pos. AFTER Value to be on the first position after adjusting the object.
- 2nd adjusting pos. BEFORE Value measured at the second adjusting position during measurement
- 2nd adjusting pos. AFTER Value to be on the second position after adjusting the object.
- Accumulated deviation: Difference between the two endpoints of the measured line (This is the value the object must be adjusted)
- Maximum deviation: This is the max. straightness deviation of the measured line absolute
- Correction: The complete object must be adjusted by this angle [µm/m]. The value corresponds to the display on the instrument at the adjusting positions BEFORE - AFTER
- Maximum deviation: (Straightness) Straightness of the measured line after the alignment according to the "Endpoint method"

As mentioned before the individual curves can be displayed with or without numerical values.

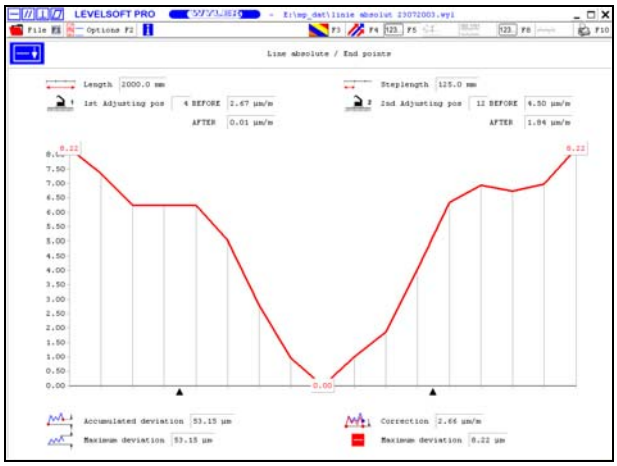


Display of the curves with all numerical values / key [F5].

Both curves individually displayed / key [F8]



Measured curve



Curve aligned according „Endpoints“

6. ANNEX

6.1 DETAILED INFORMATION CONCERNING THE THEME "ALIGNMENT OF COMPLEX MEASURING OBJECTS"

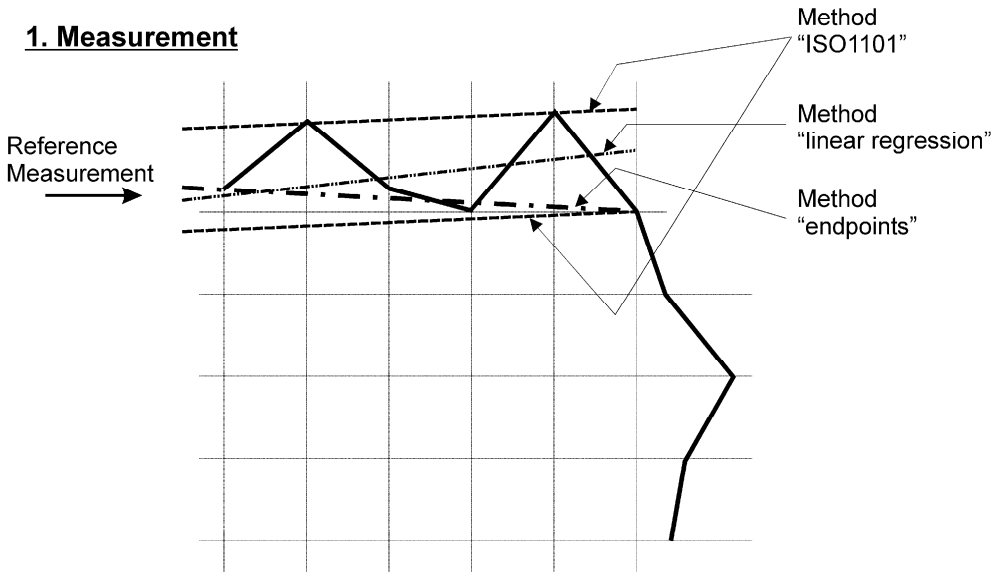
As described in chapter “3.8 Methods of alignment” a number of different principles are available when lines are concerned. The same basics do apply when angles are measured. The task is somewhat more complex due to the second dimension involved.

For all the angular measurements the following applies

1. The reference measurement is done and then aligned horizontally respectively vertically according to the known methods
   - Alignment according to the method “Endpoints”
   - Alignment according to the method “ISO 1101”
   - Alignment according to the method “linear Regression”

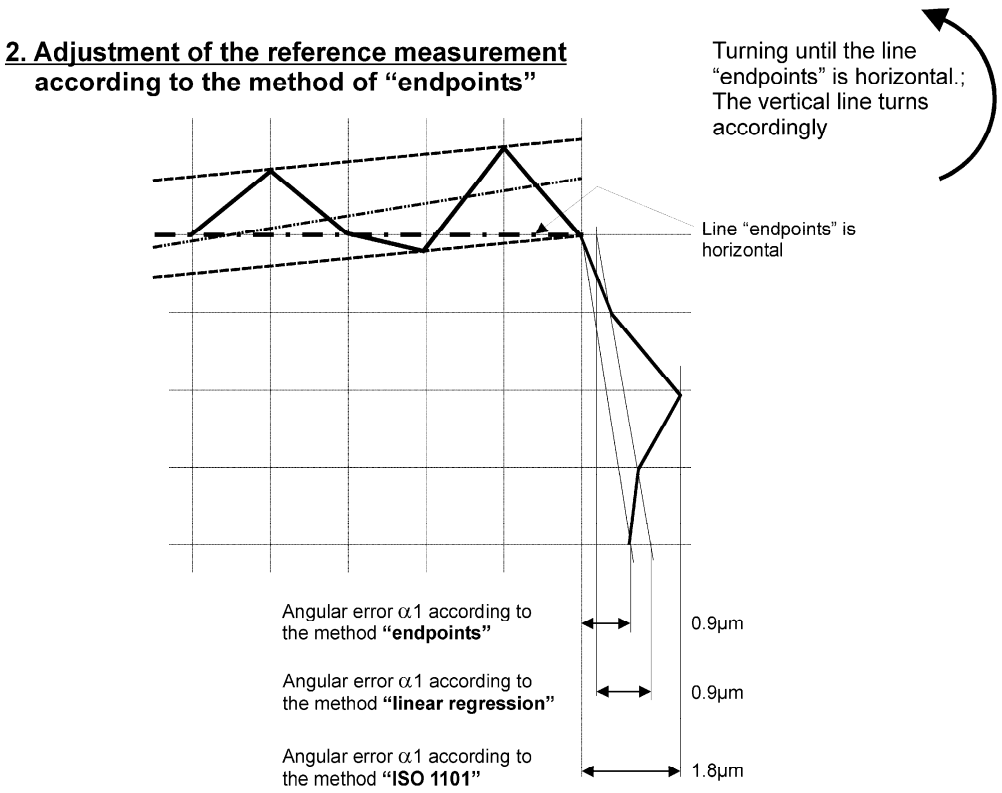
2. The second line measurement is “turned” accordingly (the same angle as the reference line is turned). The angular error may now be computed again according to the three different methods

The following graph should explain the situation:



In the graph the three different methods are displayed.

Alignment according to the method **"Endpoints"**	In this method the first and the last measured point are connected by a straight line. The whole figure is now turned horizontally. The connecting line is moved **parallel** to the highest and the lowest point of the object. The **vertical distance** between the two lines is the maximum error calculated according the method “Endpoints”.
Alignment according to the method "**ISO 1101"**	In the method ISO1101 two parallel lines are aligned in such away that the distance between them is the least possible. The **vertical distance** between the two lines is the smallest possible error according the method “ISO 1101”
Alignment according to the method **"linear Regression"**	Using the method “linear regression” a straight line is calculated out of a number of measuring points according to the method least square. The so calculated line is moved **parallel** to the highest and the lowest point of the object. The **vertical distance** between the two lines is the maximum error calculated according the method “Linear regression”.



The angular error is defined by one of the three methods, in our example first the reference measurement line is aligned according to the method “Endpoints”

Then again three methods of alignments of the second line exist so that three angular errors may be determined.

6.2 DETAILED INFORMARTION CONCERNING THE TOPIC "STANDARDS" / QUALITY OF THE MEASURED OBJECT

- Only relevant for flatness measurements (WYLER, U-Jack)
- Length and width of the object must be seen on the protocol. The descriptions of "Length" and "Width" as used up to now must be replaced by
  - "Length of grid"
  - "Width of grid"
- On the monitor as well as on the print out the following information is required:
  - Quality of measured flatness according to (Standard selectable) is e.g. Grade 00 (see example)

Formulas for the different standards are as follows:

- **DIN 876:**
  - Grade 00 < 2 x (1+L/1000) µm (L: Longer length of plate in mm)
  - Grade 0 < 4 x (1+L/1000) µm (L: Longer length of plate in mm)
  - Grade 1 <10 x (1+L/1000) µm (L: Longer length of plate in mm)
  - Grade 2 <20 x (1+L/1000) µm (L: Longer length of plate in mm)

- **JIS**
  - Grade 00 <L x 0.0015+1.25 µm (L: Diagonal of the plate in mm)
  - Grade 0 <L x 0.003+2.50 µm (L: Diagonal of the plate in mm)
  - Grade 1 <L x 0.006+5 µm (L: Diagonal of the plate in mm)
  - Grade 2 <L x 0.012+10 µm (L: Diagonal of the plate in mm)

- **GGG-P-463c**
  - Grade AA $< 40 + (D^2/25)$ D: Diagonal in inch Result in 0,000xxx inch
  - Grade A $< [40 + (D^2/25)] \times 2$ D: Diagonal in inch Result in 0,000xxx inch
  - Grade B $< [40 + (D^2/25)] \times 4$ D: Diagonal in inch Result in 0,000xxx inch

- **BS 817**

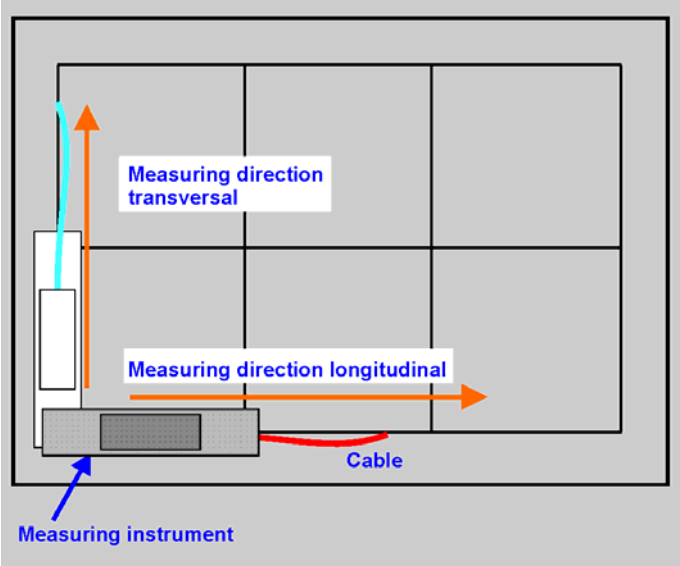
Length of plate in [mm]	**Grade 0** in [µm]	**Grade 1** in [µm]	**Grade 2** in [µm]	**Grade 3** in [µm]
180	3.0	Grade "0" x 2	Grade "0" x 4	Grade "0" x 8
250	3.5	ditto	ditto	ditto
400	4.0	ditto	ditto	ditto
630	4.5	ditto	ditto	ditto
1000	5.5	ditto	ditto	ditto
1600	7.5	ditto	ditto	ditto
2000	8.5	ditto	ditto	ditto
2500	10.0	ditto	ditto	ditto

6.3 INFORMATION ABOUT "SYMMETRIC, RESPECTIVELY ASYMMETRIC LAYOUT" OF THE MEASURING AREA

Three possibilities exist for measuring a flatness area of an object

- **Symmetric layout of the measuring area**
  The measuring instrument will be guided on the centreline of the flat base throughout the measuring area of the plate. In this case the grid is laid out symmetrically on the object.
- **Asymmetric layout of the measuring area for WYLER standard measuring bases**
  The measuring instrument will be guided along a side of the base throughout the measuring area of the plate. In this case the grid is laid out asymmetrically on the object.
- **Asymmetric layout of the measuring area for WYLER 3-point screw-on base**
  The 3-point base measuring instrument will be guided on the centreline of the contact points throughout the measuring area of the plate. In this case the grid is laid out asymmetrically on the object.

a) Measuring instrument with flat base and **<u>symmetric layout guidance</u>**

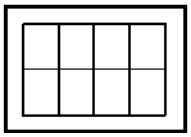


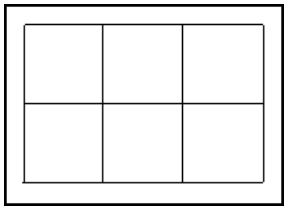
The measuring grid is drawn symmetrically on the object

The measuring instrument will be guided on the centreline of the flat base throughout the measuring area of the plate.

Using <Grid Proposal> equal border zones are to be chosen, which means symmetric layout

Symbol

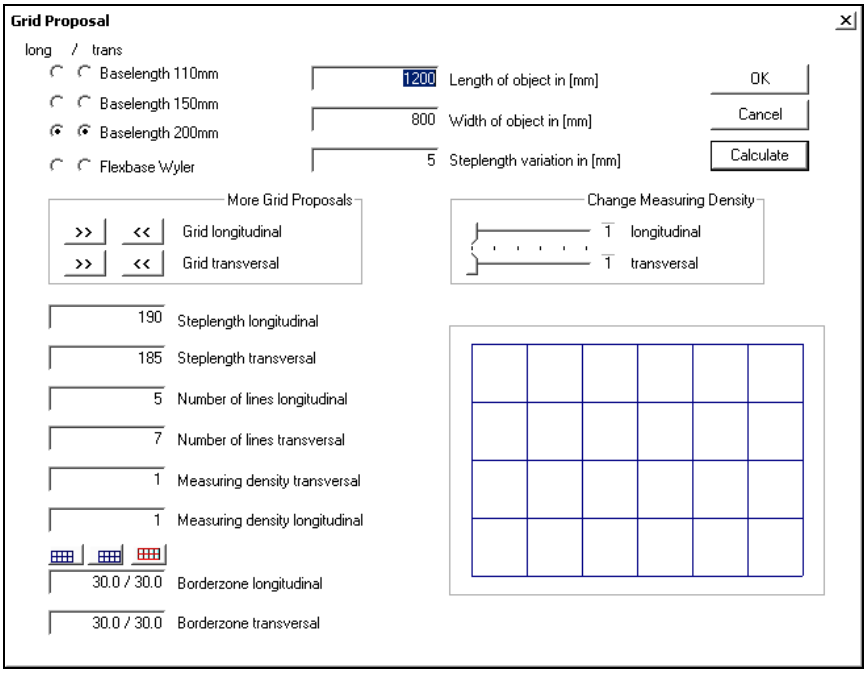




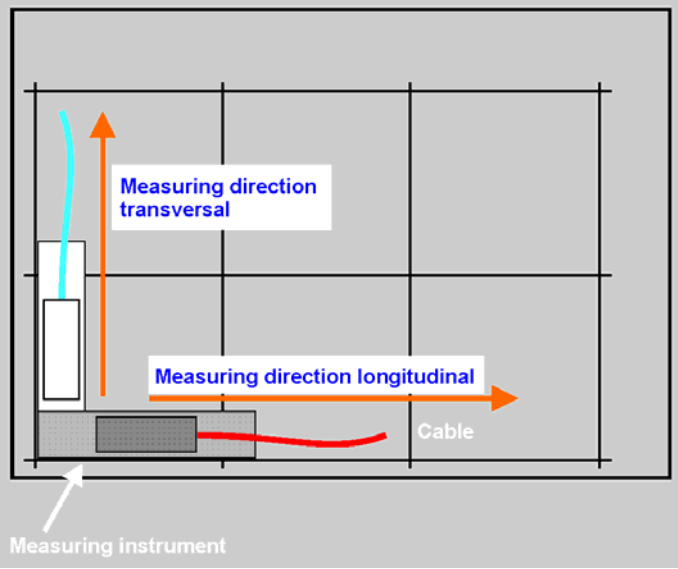
Symmetric layout

In this example the border zones are symmetric

- Border zone left and right identical
  30 mm each
- Border zone near and far identical
  30 mm each



b) Measuring instrument with flat base and **asymmetric layout guidance**

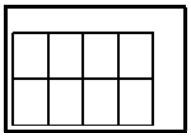


The measuring grid is drawn asymmetrically on the object

The measuring instrument will be guided along a side of the base throughout the measuring area of the plate

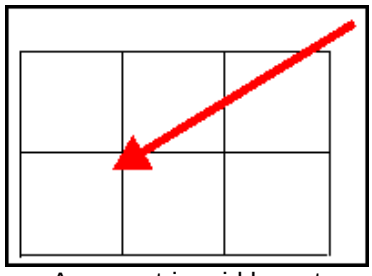
Using <Grid Proposal> unequal border zones are to be chosen, which means asymmetric layout

Symbol



In this example the border zones are asymmetric (have not the same dimension)

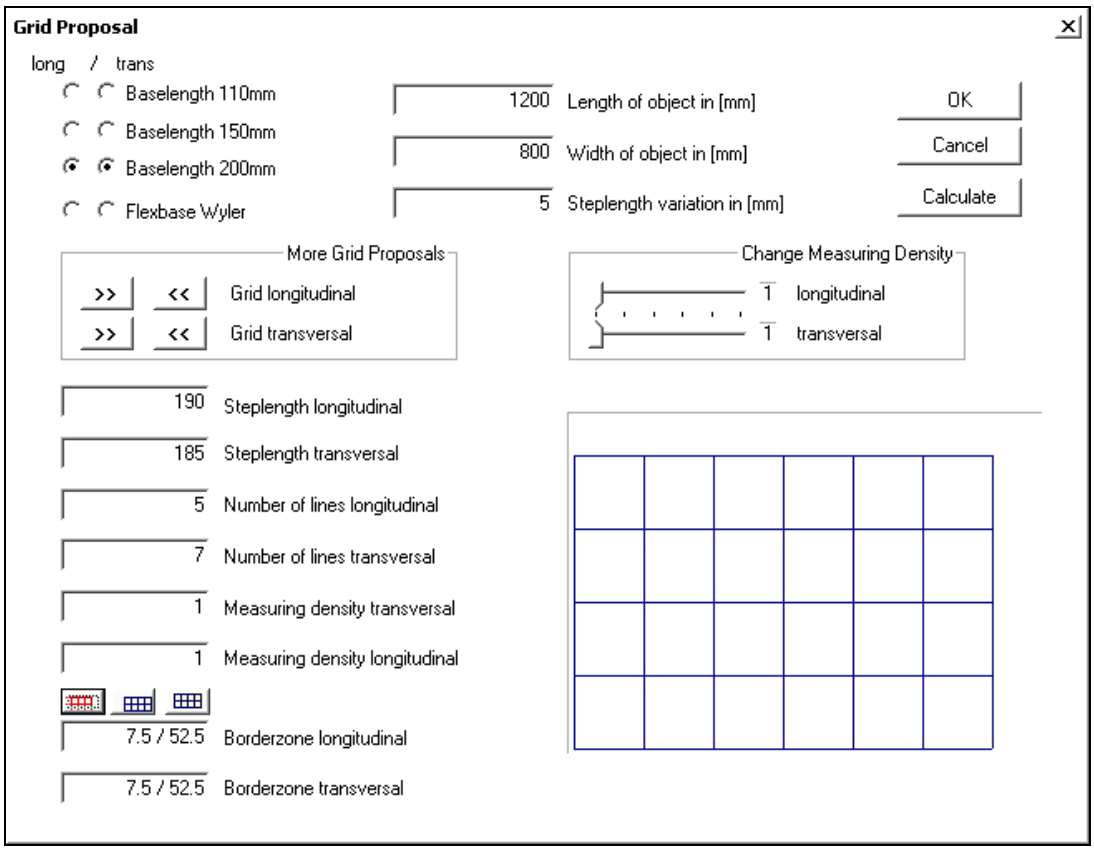
- Border zone left 7,5mm
- Border zone right 52,5mm
- Border zone near 7,5mm
- Border zone far 52,5mm



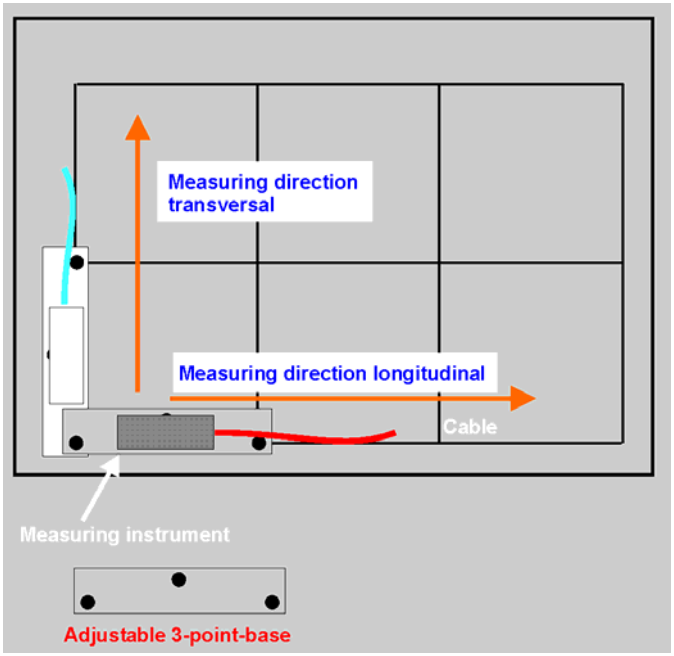
Asymmetric grid layout
(in the direction of lower left corner)

Advantage:
More precise measurement due to the easy visible guide of the lines

Disadvantage:
Asymmetric Grid



c) Measuring instrument with 3-point base and **asymmetric layout guidance**

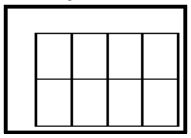


The measuring grid is drawn asymmetrically on the object

The 3-point base measuring instrument will be guided on the centreline of the contact points throughout the measuring area of the plate.

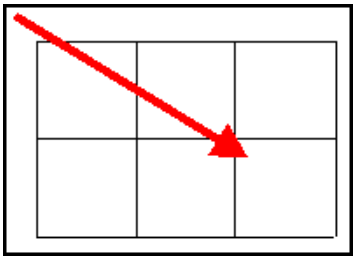
Important:
The first contact point in longitudinal direction and in transversal direction must be identical!!

Symbol



In this example the border zones are asymmetric (have not the same dimension)

- Border zone left 52,5mm
- Border zone right 7,5mm
- Border zone near 7,5mm
- Border zone far 52,5mm

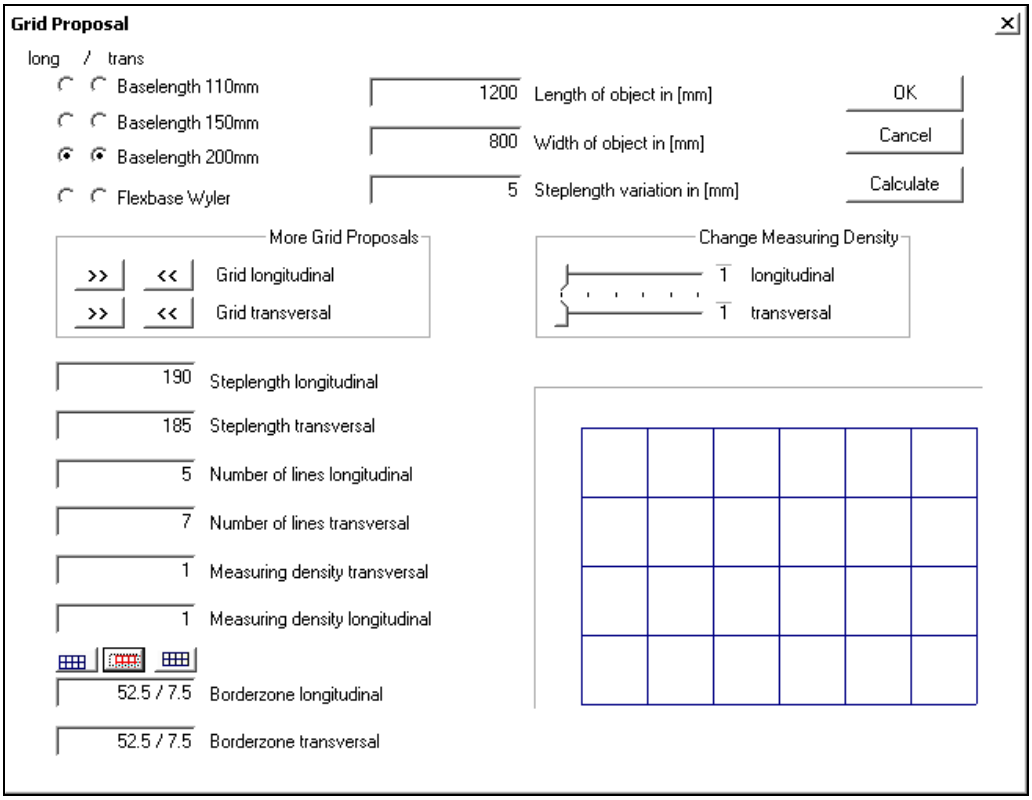


Asymmetric grid layout
(in the direction of lower right corner)

Contrary to option b) the layout is drawn in the direction of the lower right corner. The border zone is left larger than right!

Advantage:
More precise measurement due to the easy visible guide of the lines

Disadvantage:
Asymmetric Grid



WYLER AG
Im Hölderli
CH-8405 WINTERTHUR
Switzerland

Tel. 0041 (0) 52 233 66 66
Fax. 0041 (0) 52 233 20 53

Homepage: http://www.wylerag.com
E-Mail: wyler@wylerag.com